EXHIBIT 2

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

TELECOM NETWORK SOLUTIONS, LLC, *Plaintiff,* v. AT&T CORP., AT&T COMMUNICATIONS LLC, AT&T MOBILITY LLC, AT&T MOBILITY II LLC, and AT&T SERVICES INC. *Defendants.*	§ § § § § § § § § § §	Case No. 2:21-cv-00415-JRG (Lead Case) JURY TRIAL DEMANDED
TELECOM NETWORK SOLUTIONS, LLC, *Plaintiff,* v. VERIZON COMMUNICATIONS, INC., et al *Defendants.*	§ § § § § § § § § § §	Case No. 2:21-cv-00416-JRG (Member Case)
TELECOM NETWORK SOLUTIONS, LLC, *Plaintiff,* v. T-MOBILE USA, INC., et al *Defendants.*	§ § § § § § § § § § §	Case No. 2:21-cv-00418-JRG (Member Case)

PLAINTIFF'S DISCLOSURE OF ASSERTED CLAIMS AND INFRINGEMENT CONTENTIONS AND DOCUMENT PRODUCTION ACCOMPANYING DISCLOSURE PURSUANT TO P.R. 3-1 & 3-2

Pursuant to Patent Rules 3-1 and 3-2, Plaintiff Telecom Network Solutions, LLC ("TNS" or "Plaintiff") hereby provides its Disclosure of Asserted Claims and Infringement Contentions and its Document Production Accompanying Disclosure against Defendants AT&T Corp., AT&T Communications LLC, AT&T Mobility LLC, AT&T Mobility II LLC, and AT&T Services Inc. ("AT&T" or "Defendants").

Plaintiff presents these Infringement Contentions based on Plaintiff's analysis of the facts currently known based on Plaintiff's review of certain publicly available information. Plaintiff reserves the right to amend or further supplement these disclosures—including to supplement its infringement contentions pursuant to P.R. 3-6—with additional information learned in the course of discovery or further investigation concerning Defendants' products or services.

I. TNS' P.R. 3-1 Disclosures

A. P.R. 3-1(a): Infringed Claims

Subject to ongoing discovery and investigation, TNS asserts that Defendants infringe claims 1-2, 4-11, 13-15, 17-21, 23, 25-29, and 31-42 (collectively, "Asserted Claims") of U.S. Patent No. RE47,813 (the "'813 Patent") directly under 35 U.S.C. § 271(a) by making, using, offering to sell and/or selling the Accused Instrumentalities set forth in Part I.B below.

TNS reserves the right to supplement its position as to infringement following further discovery and/or claim construction.

B. P.R. 3-1(b): Accused Instrumentalities

Subject to ongoing discovery and investigation, and based on present information and belief, Plaintiff contends that the Asserted Claims are infringed by Defendants' products and services identified in the chart attached hereto as Exhibit A ("Accused Instrumentalities") including but not limited to the system components implementing a dynamic allocation of network resources in Defendants' 3G, 4G, 4G LTE, and 5G networks.

Plaintiff reserves the right to supplement its infringement contentions to identify additional products and/or services, if necessary, when it is provided with non-public documents and/or source code from third parties and/or the Defendants via the discovery process.

C. P.R. 3-1(c): Preliminary Infringement Charts

Subject to ongoing discovery and investigation, and based on present information and belief, Plaintiff contends that each element of each infringed claim is found within each Accused Instrumentality as shown in the preliminary infringement chart attached hereto as **Exhibit A** and incorporated herein in its entirety. Plaintiff's identification in the claim charts is exemplary and based upon public information currently available to Plaintiff. The accompanying document production may be found at TNS10000001-186.

Plaintiff reserves the right to amend its asserted claims and infringement contentions pursuant to P.E. 3-6 as discovery progresses and additional information is gathered.

D. P.R. 3-1(d): Literal Infringement and Infringement Under the Doctrine of Equivalents

Subject to ongoing discovery and investigation, and based on available information obtained to date, Plaintiff hereby contends that each element of each asserted claim is literally present in each of the Accused Instrumentalities as specifically shown in Exhibit A unless otherwise stated in that exhibit. As indicated above, discovery is necessary to further develop Plaintiff's infringement positions—either literal or under the Doctrine of Equivalents—and the Court has yet to issue a claim construction order. Pursuant to P.R. 3-6, Plaintiff expressly reserves the right to amend and supplement its position on whether there is infringement under the Doctrine of Equivalents of any element of any asserted claim after further discovery from the Defendants (and/or third parties) and/or pending this Court's claim construction order.

E. P.R. 3-1(e): Priority Dates

The '813 Patent is a Reissue Patent of U.S. Patent No. 8,600,850. The Reissue application was filed on August 1, 2018. The '813 Patent is entitled to priority to at least the following applications: U.S. Patent Application No. 13/515,101, now U.S. Patent No. 8,600,850, filed on August 13, 2012, which is a National Stage entry of PCT/CA2009/001809, filed December 10, 2009.

F. P.R. 3-1(f): Right to Rely on Plaintiff's Own Instrumentality

TNS does not contend that it practices the asserted claims of the '813 Patent.

II. Document Production Accompanying Disclosure

A. Documents Responsive to P.R. 3-2(a)

Plaintiff does not presently possess any relevant, non-privileged documents responsive to P.R. 3-2(a). Plaintiff will supplement this response should any relevant, non-privileged documents be identified in the future.

B. Documents Responsive to P.R. 3-2(b)

Plaintiff does not presently possess any relevant, non-privileged documents responsive to P.R. 3-2(b). Plaintiff will supplement this response should any relevant, non-privileged documents be identified in the future.

C. Documents Responsive to P.R. 3-2(c)

Pursuant to P.R. 3-2(c), a copy of the file history of the '813 Patent has been produced under Bates Numbers TNS-FH00000001-950.

III. CONCLUSION

The information contained in these disclosures is based on Plaintiff's analysis of the facts currently known to it based on Plaintiff's review of public information reasonably available to it.

Additional pertinent information about Defendants' Accused Instrumentalities is not available without engaging in further discovery. Thus, Plaintiff reserves the right to supplement, modify, and/or amend these disclosures as new information becomes available, and discovery progresses. Plaintiff anticipates that additional facts and relevant documents will be uncovered that will warrant supplementing and/or amending these disclosures.

DATED: March 2, 2022

Respectfully submitted,

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ATTORNEYS FOR PLAINTIFF TELECOM NETWORK SOLUTIONS, LLC

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the above and foregoing document has been served on all counsel of record by email on March 2, 2022.

/s/ *Blaine Larson*
Blaine Larson

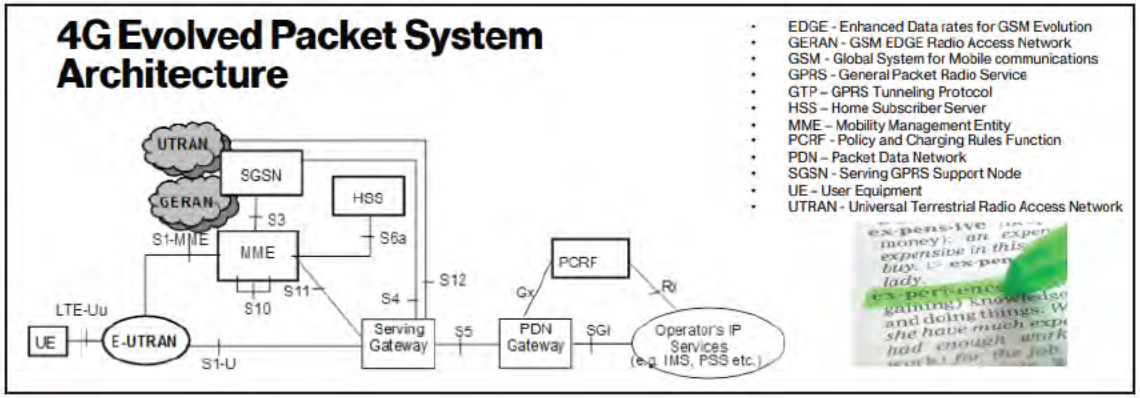
U.S. Patent No. USRE47813 (8,600,850) v. Verizon

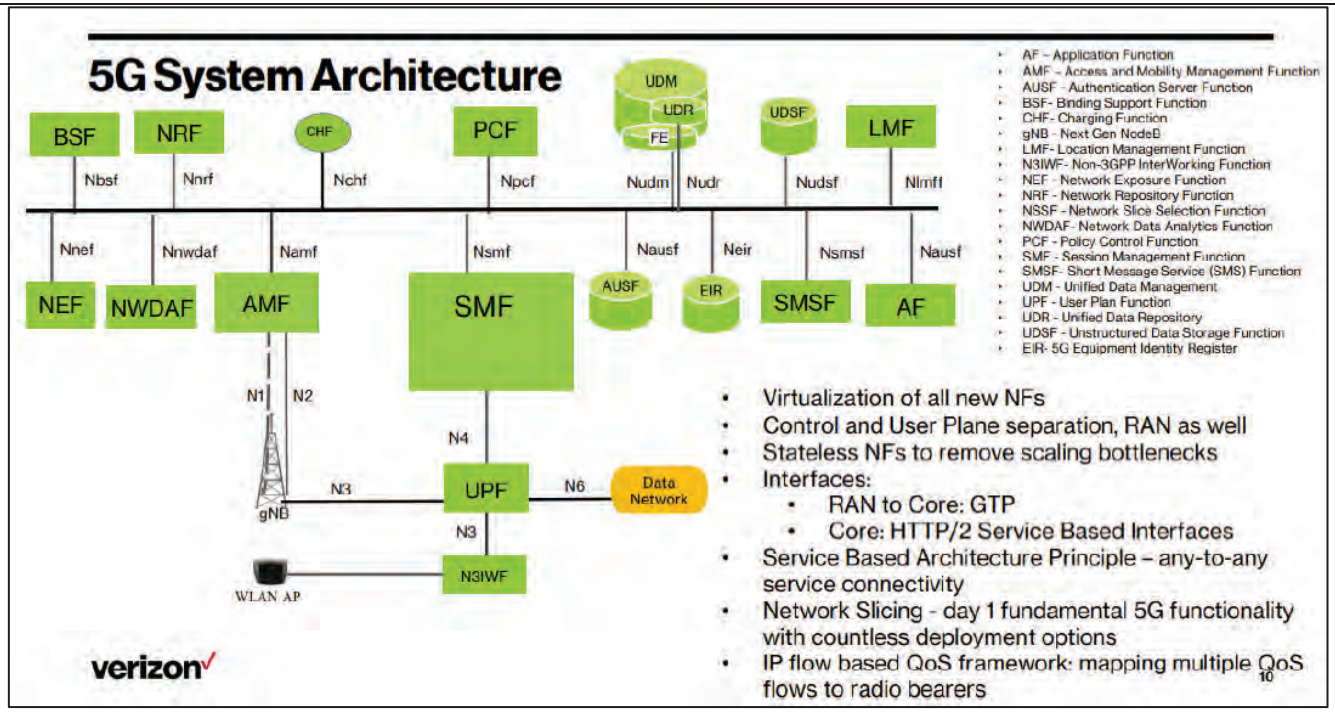
Filed: ’813 filed August 1, 2018 (’850 original 371(c) date August 13, 2012)

Priority Date: December 10, 2009 (via Canadian PCT)

Issue Date: January 14, 2020 (’850 original issued December 3, 2013)

These infringement contentions incorporate by reference the discussion and materials cited in the *Telecom Network Solutions vs. Verizon Communications, Inc. and Cellco Partnership d/b/a Verizon Wireless* Complaint filed November 9, 2021.

CLAIM 1	'813 PATENT V. VERIZON
1[A]. A method for dynamic allocation of network resources comprising:	Verizon provides network services to customers and, in doing so, implements a method for dynamic allocation of network resources. Verizon operates and sells access to its cellular communication network that provides cellular and data services to its customers via cellular base stations (also referred to at times as cell towers) located throughout the United States, and thereby directly infringes this method claim. These base stations communicate with customers' cellular devices (including mobile phones, tablets, laptops mobile hotspots, and access points) in accordance with 3G, 4G, 4G LTE and 5G mobile network standards.  https://site.ieee.org/comsoc-cqr/files/2018/05/03-Imtiaz__Shaikh__ETR2018_final.pdf (last visited Nov. 30, 2021) (hereinafter "VZNP") at 8.



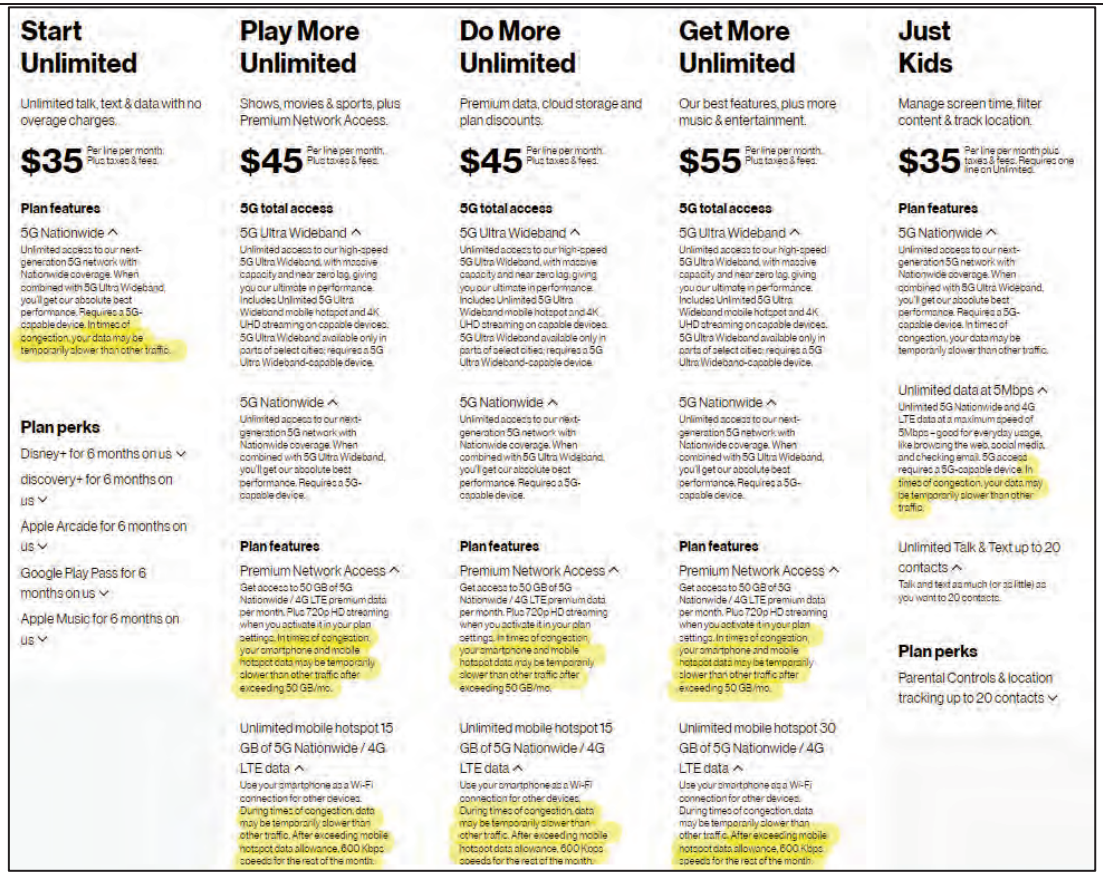
VZNP at 10.

Verizon also sells cellular devices, through its distribution channels, designed to communicate with the Verizon Network in accordance with the aforementioned mobile network standards. *See e.g.*, https://www.verizon.com/coverage-map/ (last visited January 20, 2022); https://www.verizon.com/articles/network-speed-comparison/ (last visited January 20, 2022); https://www.verizon.com/shop/online/5g-cell-phones/ (last visited January 20, 2022); https://www.verizon.com/business/shop/products/devices/all (last visited January 20, 2022).

Verizon's Broadband Internet Access Services provide a method for dynamically allocating network resources. https://www.verizon.com/support/broadband-services/ (last visited January 20, 2022) (referred to herein as "Broadband Services Information" or "BSI"). The BSI (and the Verizon website more generally) provides information regarding Verizon's "Broadband Internet Access Services" which are services "that provide the capability to transmit data to and receive data from all or substantially all Internet endpoints." BSI at 1. The "internet access through . . .

	Data Services over the Verizon Wireless 5G Ultra Wideband, 5G Nationwide, 4G LTE, or 3G (or Ev-DO) networks" are described on the Verizon website, and specifically in the BSI. BSI at 1-5. Verizon also defines the Terms and Conditions that apply to its Broadband Internet Access Services. *See* BSI at 2 ("Broadband internet services are subject to the Customer Agreement . . ., the terms of the plan or any optional services you may have selected and Important Plan Information . . . ."). Verizon offers a number of different Rate Plans and Data Plans. *See, e.g.*, https://www.verizon.com/plans/unlimited/ (referred to herein as "VZW Plans") (last visited Dec. 14, 2021). While those Plans that include dynamically varying data bit-rates have varied over time and collectively form part of these contentions, the current Verizon Plans for phones are representative. Those current Plans include Start Unlimited, Play More Unlimited, Do More Unlimited, Get More Unlimited, and Just Kids. VZW Plans at 2-3. Most of these plans include data volume caps, after which the customer is subject to having their data speeds reduced to a lower data bit rate. For example, Play More Unlimited currently has a Premium Data monthly data volume threshold/cap of 50 GB at a price of $45/line per month (and 15 GB of 4G/5G mobile hotspot data), while Start Unlimited may be subject to reduced data speeds even if a customer has not exceeded a Premium Data monthly data volume threshold/cap. Get More Unlimited has unlimited Premium Data at a price of $47/line per month (with a 40 GB cap on high-speed data for Mobile Hotspot use). VZW Plans at 2-3. Verizon also has Plans for Tablets, Smartwatches, Mobile Hotspots, Laptops, Vehicles, and Security Cameras, many of which also include monthly data volume caps. *See, e.g.*, https://www.verizon.com/plans/devices/hotspots/ (last visited March 1, 2022). Verizon for Business also offers various Rate Plans that include monthly data volume caps, including for example, Business Unlimited Advanced (100 GB monthly cap for Premium Data and 50 GB for Mobile hotspot data) and LTE Business Internet plans (monthly caps for Premium Data and 300 GB monthly data allowance, after which surplus data is subject to additional charges). *See* https://www.verizon.com/business/products/plans/ (last visited March 1, 2022). Verizon also offers prepaid plans, which depending upon the Service Plan selected, may include monthly data caps and certain data volume limits for Hotspot data. *See e.g.*, https://www.verizon.com/plans/prepaid/ (last visited March 1, 2022). As explained further below, a substantial percentage of Verizon customers may experience a lower prioritization relative to customers with more expensive plans offered by Verizon. This lower prioritization may occur because a customer has exceeded its monthly data volume cap or because the customer's plan and rate is itself assigned a lower priority than other more costly Data Plans. The net result is that these lower-priority customers are subjected to having their data rates reduced and, in at least some instances, being subject to a lower bit-rate cap than other customers

	assigned higher priority by Verizon, especially during periods and in locations where the network is congested with demand exceeding network capacity. Verizon's public documents describe infringing activities that use a prioritization policy, which implements a method for dynamic allocation of network resources for Verizon's Broadband Internet Access Services. For example, Verizon discloses that it prioritizes data services for certain customers relative to other customers during times of congestion, depending on the service plan selected by the customer and the customer's data usage. On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, Network Management ("NM") available at https://www.verizon.com/about/our-company/network-management (last visited Dec. 3, 2021) at 2; *see also* Broadband Services Information ("BSI") available at https://www.verizon.com/support/broadband-services/ (last visited Dec. 3, 2021) at 3-4.



Start Unlimited

Unlimited talk, text & data with no overage charges.

$35 Per line per month. Plus taxes & fees.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Plan perks

Disney+ for 6 months on us

discovery+ for 6 months on us

Apple Arcade for 6 months on us

Google Play Pass for 6 months on us

Apple Music for 6 months on us

Play More Unlimited

Shows, movies & sports, plus Premium Network Access.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Do More Unlimited

Premium data, cloud storage and plan discounts.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Get More Unlimited

Our best features, plus more music & entertainment.

$55 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 30 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Just Kids

Manage screen time, filter content & track location.

$35 Per line per month plus taxes & fees. Requires one line on Unlimited.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited data at 5Mbps

Unlimited 5G Nationwide and 4G LTE data at a maximum speed of 5Mbps – good for everyday usage, like browsing the web, social media, and checking email. 5G access requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited Talk & Text up to 20 contacts

Talk and text as much (or as little) as you want to 20 contacts.

Plan perks

Parental Controls & location tracking up to 20 contacts

See, e.g., VZW Plans at 2-3.

Verizon's Response

Our tailored network design includes Traffic Management that enables application differentiation and Quality of Service (QoS) over the LTE Private Network using standards-based IP packet marking. Verizon's Private Network service transports a multitude of data applications, including Voice over IP (VoIP), video and best effort applications. When there is contention for network resources, mission critical applications (i.e., VoIP) are competing with best effort applications (i.e., email) for network resources, so customers' mission critical applications may experience performance degradation (e.g., difficulty accessing Verizon's LTE network resources, variable download/upload speeds, etc.).

Today, Verizon offers network priority and preemption that allows the assignment of QoS for user profiles using the standard service control parameters defined by 3GPP and the Internet Engineering Task Force, including Access Class, Quality Class Indicator (QCI), Allocation and Retention Priority (ARP), and Differentiated Service (Diff Serve). While our network RAN deployment ensures coverage 24 hours a day, 7 days a week, and 365 days a year.

Verizon Network Technology Questionnaire, at 52.

Verizon's Response

Mobile Broadband Priority is a priority data service that signals to the network that a user has higher priority in the network to access the network and get a connection over other users. Verizon LTE network is based on 3GPP standards technology which includes device level QOS parameters that apply to each session. Verizon's network extensively uses LTE technology to provide priority data levels in the network through priority and preemption services and is also currently working on a multi -tiered approach to prioritization services which will be offered to our customers in the future.

Verizon Network Technology Questionnaire, at 49.

The 3GPP Standards[1] describe the use of certain mobile network elements, such as the Policy and Control Rules Function (PCRF), that support implementing a method for dynamic allocation of network resources. For example, the 3GPP Standards describe the use of a Policy and Charging Control (PCC) architecture to implement policy decisions between a 3GPP access UE and a cellular provider's IP services network.

> 1 Scope
>
> The present document specifies the overall stage 2 level functionality for Policy and Charging Control that encompasses the following high level functions for IP-CANs (e.g. GPRS, Fixed Broadband, EPC, etc.):
>
> - Flow Based Charging for network usage, including charging control and online credit control, for service data flows and application traffic;
> - Policy control (e.g. gating control, QoS control, QoS signalling, etc.).
>
> The present document specifies the Policy and Charging Control functionality for Evolved 3GPP Packet Switched domain, including both 3GPP accesses GERAN/UTRAN/E-UTRAN and Non-3GPP accesses, according to TS 23.401 [17] and TS 23.402 [18].

3GPP TS 23.203 at 14.

> **IP-CAN session:** The association between a UE and an IP network. The association is identified by one IPv4 and/or an IPv6 prefix together with UE identity information, if available, and a PDN represented by a PDN ID (e.g. an APN). An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as UE IP addresses/prefix are established and announced to the IP network.

3GPP TS 23.203 at 17.

[1] Unless stated otherwise, the "3GPP Standards" document citations/excerpts herein refer to 3GPP TS 23.203 (ETSI TS 123.203), Version 16.2.0, Release 16 (2020-11), 3GPP TS 23.401 (ETSI TS 123.401), Version 16.11.0, Release 16 (2021-09), 3GPP TS 23.503 (ETSI TS 123.503), Version 16.5.0, Release 16 (2020-09). On information and belief, the implementation of the Verizon network complies with the 3GPP standard. *See* VZNP at 8, 10.

The following figures illustrate logical architectures for implementing PCC:

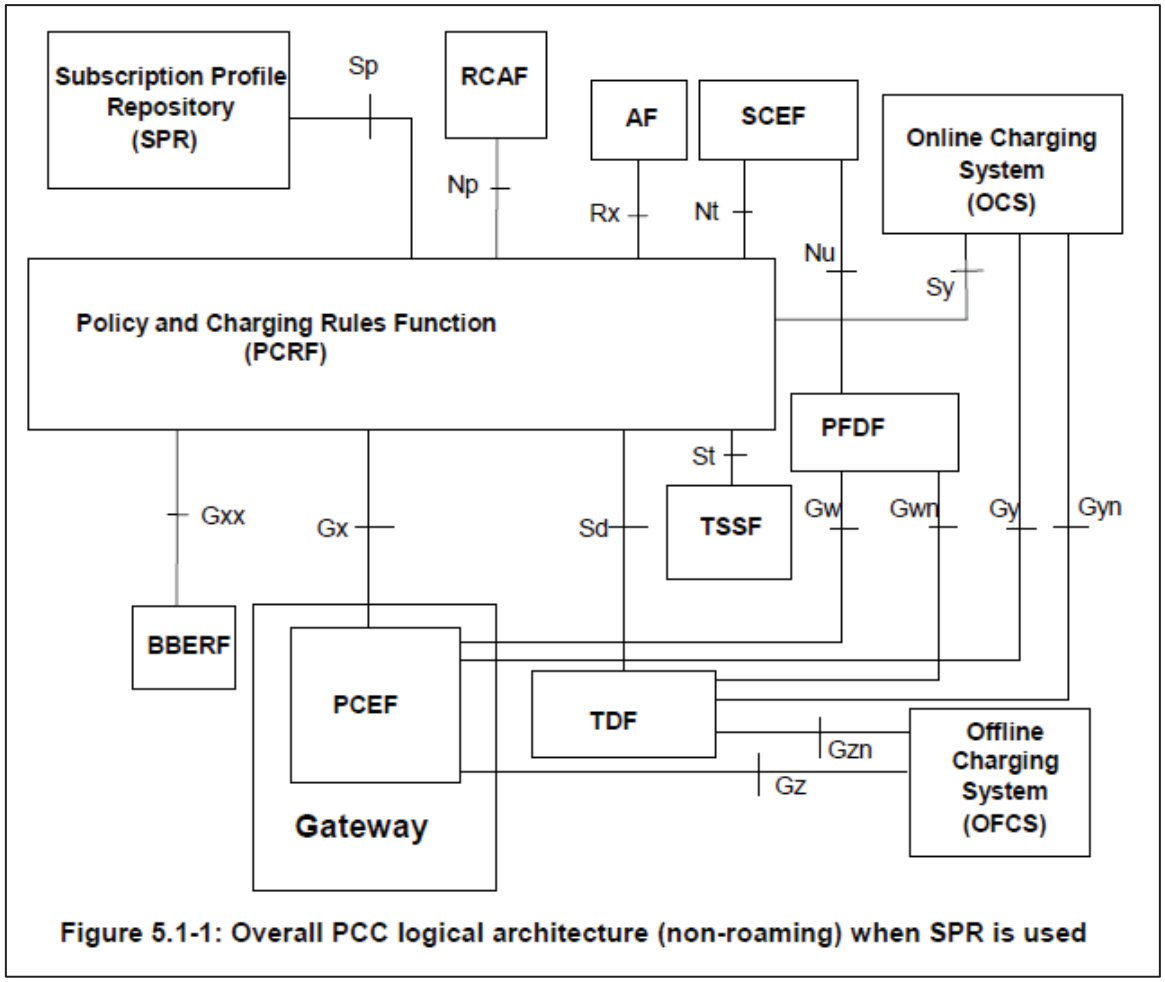


Figure 5.1-1: Overall PCC logical architecture (non-roaming) when SPR is used

3GPP TS 23.203 at 28 (PCC logical architecture with Subscription Profile Repository).

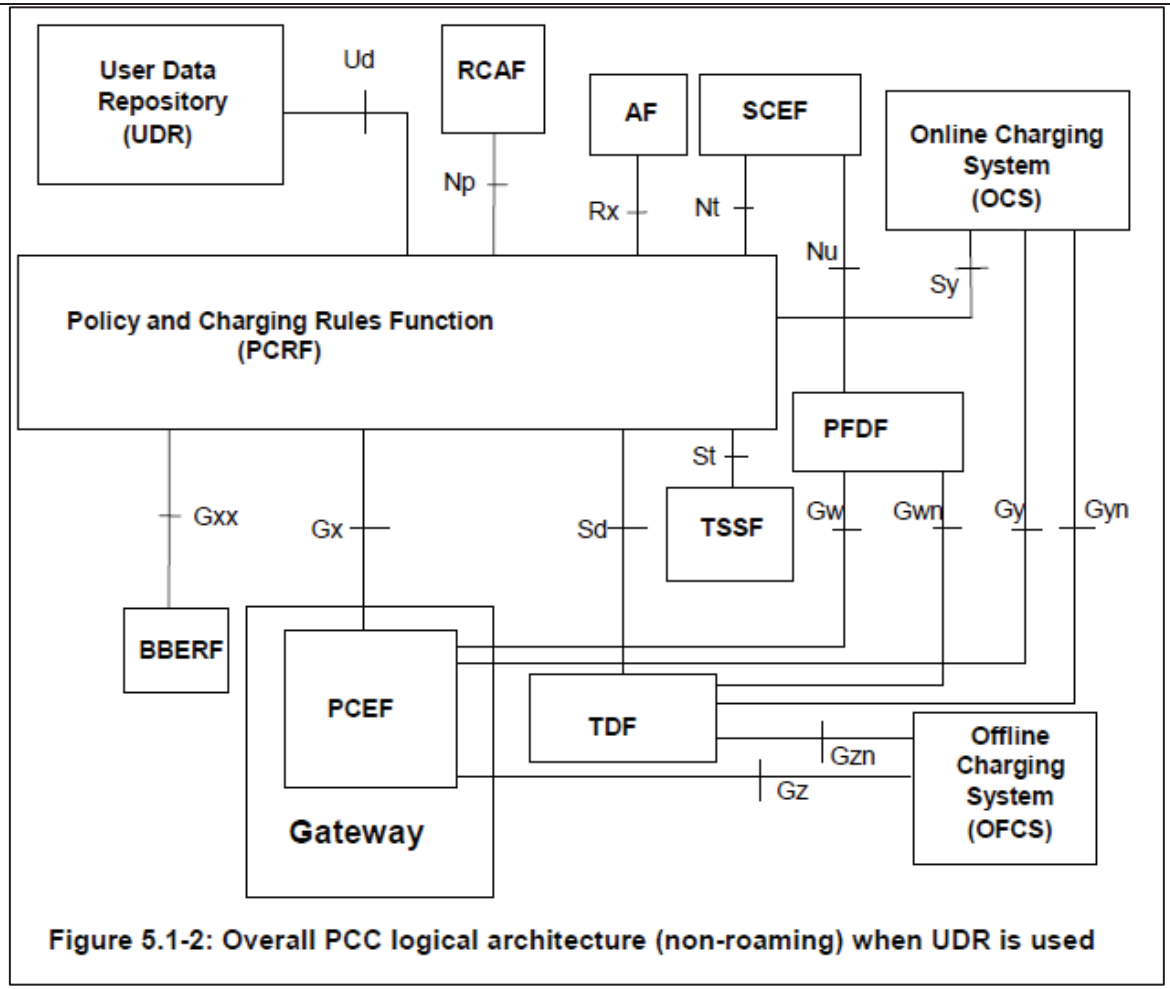


Figure 5.1-2: Overall PCC logical architecture (non-roaming) when UDR is used

3GPP TS 23.203 at 29 (PCC logical architecture when User Data Repository is used); *see also id.* at 29-30 (illustrating similar architectures that support roaming).

	The PCRF is described below: 6.2.1 Policy Control and Charging Rules Function (PCRF) 6.2.1.0 General The PCRF encompasses policy control decision and flow based charging control functionalities. The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF. The PCRF provides network control regarding the application detection, gating, QoS and application based charging (except credit management) towards the TDF and the PCEF enhanced with ADC. The PCRF shall apply the security procedures, as required by the operator, before accepting service information from the AF. The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information. The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile. 3GPP TS 23.203 at 71.

The PCRF also uses PCC rules to implement its policies, and some of these rules are dynamically modified.

6.3 Policy and charging control rule

6.3.1 General

The Policy and charging control rule (PCC rule) comprises the information that is required to enable the user plane detection of, the policy control and proper charging for a service data flow. The packets detected by applying the service data flow template of a PCC rule form a service data flow.

Two different types of PCC rules exist: Dynamic rules and predefined rules. The dynamic PCC rules are provisioned by the PCRF via the Gx reference point, while the predefined PCC rules are directly provisioned into the PCEF and only referenced by the PCRF. The usage of predefined PCC rules for QoS control is possible if the BBF remains in the PCEF during the lifetime of an IP-CAN session. In addition, predefined PCC rules may be used in a non-roaming situation and if it can be guaranteed that corresponding predefined QoS rules are configured in the BBF and activated along with the predefined PCC rules.

NOTE 1: The procedure for provisioning predefined PCC rules is out of scope for this specification.

NOTE 2: There may be another type of predefined rules that are not explicitly known in the PCRF and not under the control of the PCRF. The operator may define such predefined PCC rules, to be activated by the PCEF on one IP-CAN bearer within the IP-CAN session. The PCEF may only activate such predefined PCC rules if there is no UE provided traffic mapping information related to that IP-CAN bearer. The IP-CAN session termination procedure deactivates such predefined PCC rules.

There are defined procedures for activation, modification and deactivation of PCC rules (as described in clause 6.3.2). The PCRF may activate, modify and deactivate a PCC rule at any time, over the Gx reference point. However, the modification procedure is applicable to dynamic PCC rules only.

3GPP TS 23.203 at 99.

	The PCRF "uses usage monitoring for making dynamic policy decisions": **4.4 Usage Monitoring Control** It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per IP-CAN session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time. The PCRF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the PCEF or TDF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCRF may send both thresholds to the PCEF or TDF. The PCEF or TDF shall notify the PCRF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the PCEF or TDF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached. NOTE: There are reasons other than reaching a threshold that may cause the PCEF/TDF to report accumulated usage to the PCRF as defined in clauses 6.2.2.3 and 6.6.2. The usage monitoring capability shall be possible for an individual or a group of service data flow(s), or for all traffic of an IP-CAN session in the PCEF. When usage monitoring for all traffic of an IP-CAN session is enabled, it shall be possible to exclude an individual SDF or a group of service data flow(s) from the usage monitoring for all traffic of this IP-CAN session. It shall be possible to activate usage monitoring both to service data flows associated with predefined PCC rules and dynamic PCC rules, including rules with deferred activation and/or deactivation times while those rules are active. 3GPP TS 23.203 at 25.

	The PCRF gathers information from other sources as well to support its implementation of policy within the network: **5.2.2 Gx reference point** The Gx reference point resides between the PCEF and the PCRF. The Gx reference point enables the PCRF to have dynamic control over the PCC behaviour at a PCEF. The Gx reference point enables the signalling of PCC decision, which governs the PCC behaviour, and it supports the following functions: - Establishment of Gx session (corresponding to an IP-CAN session) by the PCEF; - Request for PCC decision from the PCEF to the PCRF; - Provision of IP flow mobility routing information from PCEF to PCRF; this applies only when IP flow mobility as defined in TS 23.261 [23] is supported; - Provision of PCC decision from the PCRF to the PCEF; - Reporting of the start and the stop of detected applications and transfer of service data flow descriptions and application instance identifiers for detected applications from the PCEF to the PCRF; - Reporting of the accumulated usage of network resources on a per IP-CAN session basis from the PCEF to the PCRF; - Delivery of IP-CAN session specific parameters from the PCEF to the PCRF or, if Gxx is deployed, from the PCRF to the PCEF per corresponding request; - Negotiation of IP-CAN bearer establishment mode (UE-only or UE/NW); - Termination of Gx session (corresponding to an IP-CAN session) by the PCEF or the PCRF. 3GPP TS 23.203 at 31.

5.2.12 Np reference point

The Np reference point resides between the RCAF and the PCRF.

The Np reference point enables transport of RAN User Plane Congestion Information (RUCI) sent from the RCAF to the PCRF for all or selected subscribers, depending on the operator's congestion mitigation policy.

The Np reference point supports the following functions:

- Reporting of RUCI from the RCAF to the PCRF.
- Sending, updating and removal of the reporting restrictions from the PCRF to the RCAF as defined in clause 6.1.15.2.

3GPP TS 23.203 at 34.

6.1.15 Reporting of RAN user plane congestion information

6.1.15.1 General

RAN User Plane Congestion Information (RUCI) is reported to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

The RUCI includes the following information:

- The IMSI identifying the UE impacted by congestion;
- eNB identifier, ECGI or SAI identifying the eNB, E-UTRAN cell or Service Area, respectively, serving the UE.

NOTE: Whether in case of E-UTRAN the eNB identifier or the ECGI is included in the RUCI is up to operator configuration in the RCAF.

- APN for which congestion information is reported;
- Congestion level or an indication of the "no congestion" state.

3GPP TS 23.203 at 62.

The 3GPP Standards further describe that the PCRF may interface with other components, including the Bearer Binding and Event Reporting Function (BBERF), to implement policy decisions for UEs accessing non-3GPP mobile networks.

> Annex H (normative):
> Access specific aspects (EPC-based Non-3GPP)
>
> H.1 General
>
> An EPC-based non-3GPP IP-CAN (TS 23.402 [18]), which requires the Gxa for dynamic QoS control, shall include the BBERF. The allocation of a BBERF to a node within the non-3GPP IP-CAN is out of 3GPP scope, unless otherwise specified in this Annex.
>
> H.2 EPC-based cdma2000 HRPD Access
>
> In case of EPC-based cdma2000 HRPD access the BBERF is located in the HRPD Serving Gateway (HSGW) defined in 3GPP2 X.S0057 [20].
>
> The HSGW of an EPC-based cdma2000 HRPD access that supports a Gxa interface shall support all the Gxa procedures defined in this specification.

3GPP TS 23.203 at 200.

> 4.1 General requirements
>
> It shall be possible for the PCC architecture to base decisions upon subscription information.
>
> It shall be possible to apply policy and charging control to any kind of 3GPP IP-CAN and any non-3GPP accesses connected via EPC complying with TS 23.402 [18]. Applicability of PCC to other IP-CANs is not restricted. However, it shall be possible for the PCC architecture to base decisions upon the type of IP-CAN used (e.g. GPRS, etc.).

3GPP TS 23.203 at 20.

	On information and belief, Verizon's network architecture is similar to such PCC architectures and includes components like a PCRF that interfaces with other network elements to enforce policy and charging rules, such as the Traffic Detection Function (TDF), Policy and Charging Enforcement Function (PCEF), Packet Data Network Gateway (P-GW), Serving Gateway (S-GW), and LTE Radio Access Network (E-UTRAN). In addition, Verizon's network architecture includes analogous systems described in the 3GPP Standards for 5G mobile networks to implement a method for dynamic allocation of network resources. The policy and charging control framework of the 5G system relates to the dynamic allocation of network resources. **1 Scope** The present document defines the Stage 2 policy and charging control framework for the 5G System specified in TS 23.501 [2] and TS 23.502 [3]. The policy and charging control framework encompasses the following high level functions: - Flow Based Charging for network usage, including charging control and online credit control, for service data flows; - Policy control for session management and service data flows (e.g. gating control, QoS control, etc.); - Management for access and mobility related policies; - Management for UE access selection and PDU Session selection related policies. 3GPP TS 23.503 at 7. In particular, the policies impact the PDU Sessions within the network.

The 5G System policy and charging control framework is described with both a service-based representation and a reference point representation:

> 5.1 General
>
> This specification describes the policy and charging control framework for the 5G system. The interaction between network functions is represented in two ways.
>
> - A service-based representation, where network functions enable other authorized network functions to access their services. This representation also includes point-to-point reference points where necessary.
> - A reference point representation, which shows that interactions exist between those network functions for which a reference point is depicted between them.

3GPP TS 23.503 at 17.

The reference architecture is comprised of the functions of many components:

> The reference architecture of policy and charging control framework for the 5G System is comprised by the functions of the Policy Control Function (PCF), the Session Management Function (SMF), the User Plane Function (UPF), the Access and Mobility Management Function (AMF), the Network Exposure Functionality (NEF), the Network Data Analytics Function (NWDAF), the Charging Function (CHF), the Application Function (AF) and UDR (Unified Data Repository).

3GPP TS 23.503 at 17.

The following diagram illustrates the 5G policy and charging control framework as a service-based representation:

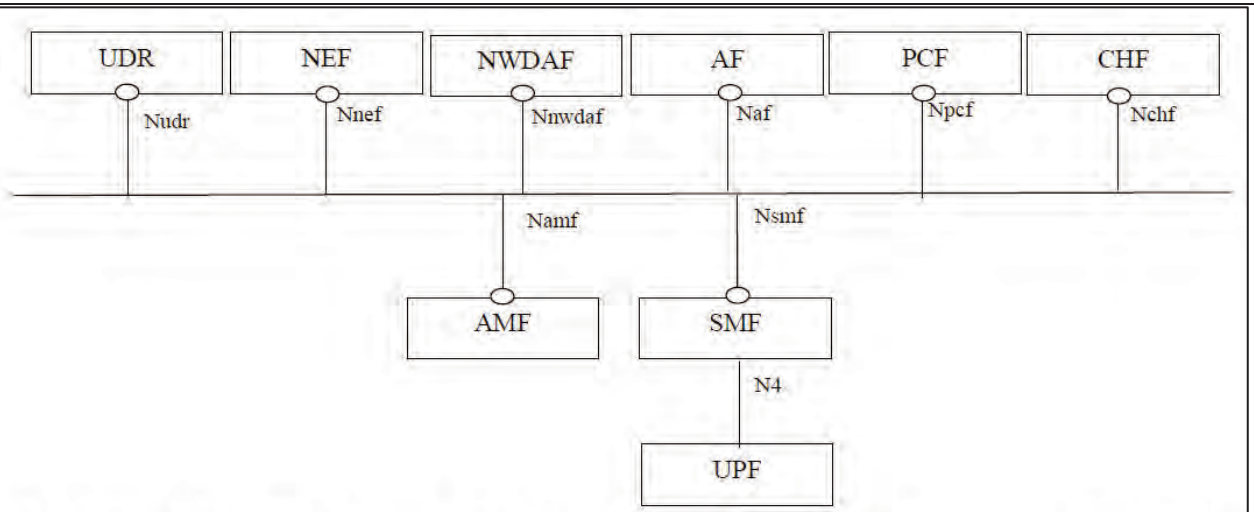
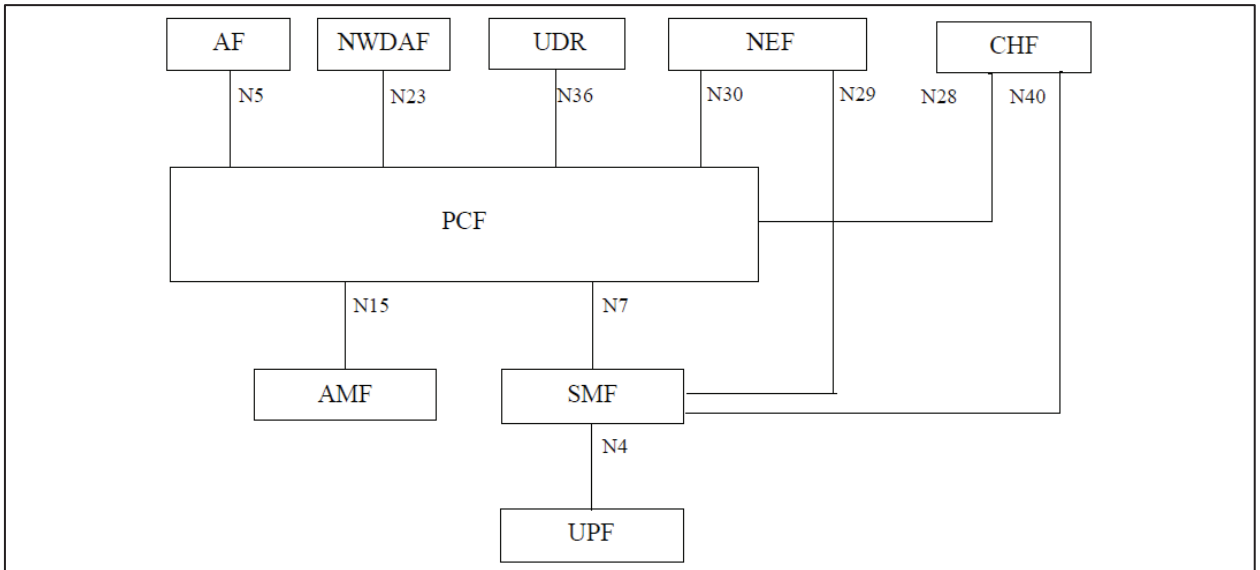


Figure 5.2.1-1: Overall non-roaming reference architecture of policy and charging control framework for the 5G System (service based representation)

3GPP TS 23.503 at 18.

	The following diagram illustrates the 5G policy and charging control framework as a reference point representation.  **Figure 5.2.1-1a: Overall non-roaming reference architecture of policy and charging control framework for the 5G System (reference point representation)** 3GPP TS 23.503 at 18; *see also id.* at 18-20 (providing other PCC framework architecture diagrams). The PCF receives and uses information from various sources to make its policy-based decisions. Several examples are provided below.

6.2.1 Policy Control Function (PCF)

6.2.1.1 General

6.2.1.1.1 Session management related functionality

The PCF provides the following session management related functionality:

- Policy and charging control for a service data flows;
- PDU Session related policy control;
- PDU Session event reporting to the AF.

The PCF provides authorized QoS for a service data flow and other network control regarding service data flow detection, gating, QoS and charging (except credit management) towards the SMF.

The PCF uses the service information received from the AF (e.g. SDP information or other available application information) and/or the subscription information received from the UDR to calculate the proper QoS authorization (QoS class identifier, bitrates). The PCF may also take into account the requested QoS received from the SMF and the analytics information (e.g. analytics related to "Service Experience") received from the NWDAF.

3GPP TS 23.503 at 60.

4.2.3 Network analytics information requirements

The PCF shall be able to collect directly network analytic information from the NWDAF. The NWDAF provides network data analytics (e.g. load level information on a network slice level) to PCF. The PCF shall be able to use those data in its policy decisions. The details are defined in clause 6.1.1.3.

3GPP TS 23.503 at 12.

4.3.4 Usage monitoring control requirements

The requirements to monitor, both volume and time usage, and report the accumulated usage of network resources apply for PDU Sessions of type IP and Ethernet.

It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per Session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time.

The PCF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the SMF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCF may send both thresholds to the SMF. The SMF shall notify the PCF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the SMF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached.

3GPP TS 23.503 at 16

5.3.2 Interactions between PCF and SMF

Npcf and Nsmf enable the PCF to have dynamic control over the policy and charging behaviour at a SMF.

Npcf and Nsmf enable the signalling of policy and charging control decisions and support the following functionality:

- Creation of a SM Policy Association as defined in clause 4.16 of TS 23.502 [3];
- Request for policy and charging control decision from the SMF to the PCF when a Policy Control Request Trigger related to Session Management has been met;
- Provision of policy and charging control decision from the PCF to the SMF;
- Deletion of a SM Policy Association as defined in clause 4.16 of TS 23.502 [3].

The N7 reference point is defined for the interactions between PCF and SMF in the reference point representation.

3GPP TS 23.503 at 21.

5.3.11 Interactions between NWDAF and PCF

The Nnwdaf enables the PCF to subscribe to and be notified on slice load level analytics. The following information are notified by the NWDAF:

- Identifier of network slice instance;
- Load level information of network slice instance.

NOTE: How this information is used by the PCF is not standardized in this release of the specification.

The Nnwdaf enables the PCF to request or subscribe to and be notified on observed service experience (i.e. the average observed Service MoS) as described in clause 6.4 of TS 23.288 [24].

The Nnwdaf enables the PCF to request or subscribe to and be notified on network performance as described in clause 6.6 of TS 23.288 [24].

The Nnwdaf enables the PCF to request or subscribe to and be notified on UE related analytics as described in clause 6.7 of TS 23.288 [24].

The N23 reference point is defined for the interactions between NWDAF and PCF in the reference point representation.

3GPP TS 23.503 at 23-24.

6.1.1.3 Policy decisions based on network analytics

Policy decisions based on network analytics allow PCF to perform policy decisions taking into account the analytics information provided by the NWDAF. The PCF subscribes/unsubscribes to Analytics information as defined in TS 23.288 [24].

The following Analytics IDs are relevant for Policy decisions: "Load level information", "Service Experience", "Network Performance" and "Abnormal behaviour". The PCF may subscribe to notifications of network analytics related to "Load Level Information" using the Nnwdaf_AnalyticsSubscription_Subscribe service operation including the Analytics ID "Load level information", the Analytics Filter "S-NSSAI and NSI ID" and the Analytics Reporting Information set to a load level threshold value. The PCF is notified when the load level of the Network Slice Instance reaches the threshold, and then the PCF may verify if the RFSP index value needs to be modified for a SUPI for which an AM Policy Association is created; this is based on operator policies in the PCF, as defined in clause 6.1.2.1.

3GPP TS 23.503 at 26.

	6.2.1.7 Usage monitoring The PCF supports usage monitoring control for a PDU Session or per Monitoring Key. Usage is defined as either volume or time of user plane traffic. The PCF may receive usage monitoring related information per DNN and S-NSSAI combination and UE from the UDR, i.e. the overall amount of allowed resources (based either on traffic volume and/or traffic time) that are to be monitored for the PDU Sessions of a user, together with the corresponding remaining allowed usage related information. In addition, usage monitoring related information for Monitoring key(s) per DNN and S-NSSAI combination and UE may also be received from the UDR, together with the corresponding remaining allowed usage related information. For the purpose of usage monitoring per access type, the PCF receives an individual Monitoring key per access type from UDR. Details about the usage monitoring related information and the remaining allowed usage related information provided by the UDR are described in clause 6.2.1.3. For the purpose of usage monitoring control the PCF shall request the Usage report trigger and provide the necessary usage threshold(s), either volume threshold, time threshold, or both volume threshold and time threshold, upon which the SMF shall report to the PCF. The PCF shall decide if and when to activate usage monitoring to the SMF. The PCF may provide a Monitoring time to the SMF for the Monitoring keys(s) and optionally specify a subsequent threshold value for the usage after the Monitoring time. 3GPP TS 23.503 at 62.

The 3GPP Standards further describe that the PCRF may interface with other components, including the Bearer Binding and Event Reporting Function (BBERF), to implement policy decisions for 3G/EV-DO UEs.

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3GPP TS 23.203 at 200.

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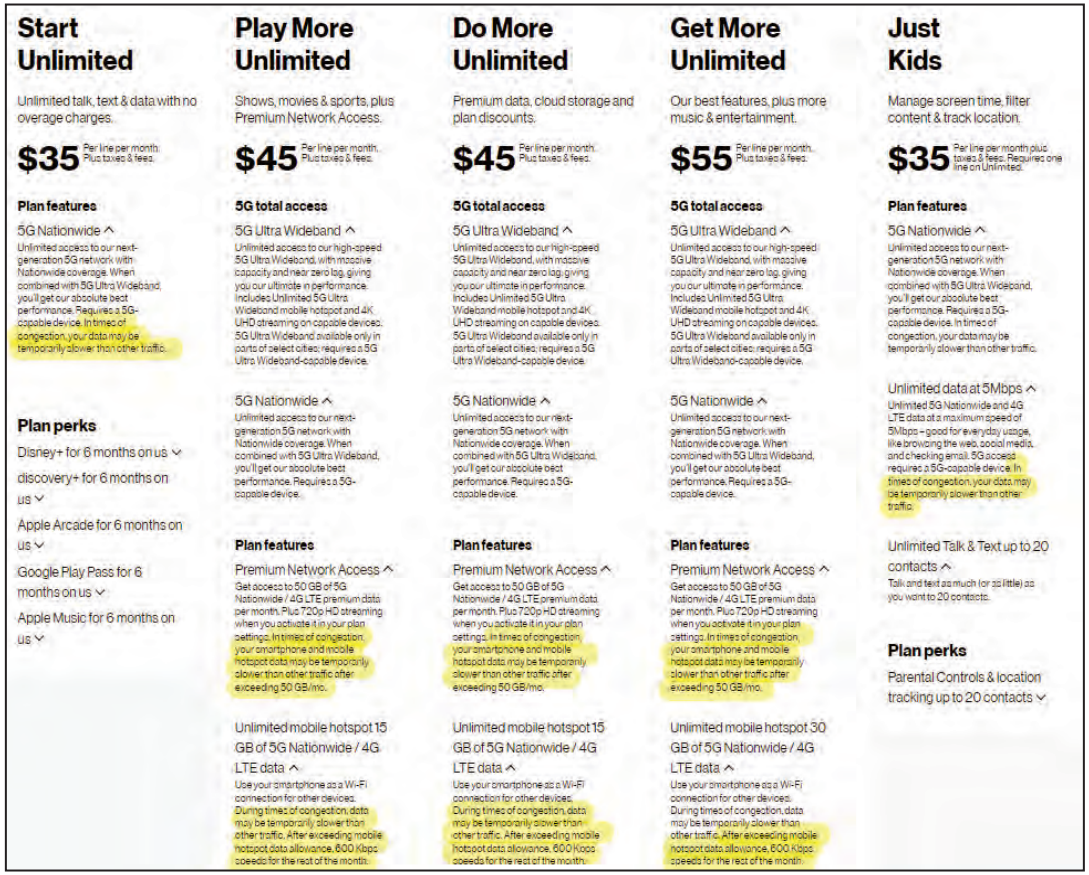
3GPP TS 23.203 at 20.

Further discovery will be necessary to determine the details regarding the manner in which this method is actually implemented within the Verizon network and to identify the specific devices which implement this method, but the publicly available documentation makes it evident that Verizon is performing the method in the manner set forth in

	the asserted claims. All Verizon plans that dynamically modify a particular customer's network access (e.g., data rates) relative to other customers (e.g., based upon either exceeding a data volume cap and/or having elected a less costly Rate Plan that provides lower bit-rate caps relative to other higher priority traffic) during periods of network congestion form part of the infringing activities of Verizon.
1[B] receiving a service profile for each of a plurality of devices sharing a network resource;	Verizon's implementation of dynamic allocation of network resources includes performing the step of receiving a service profile for each of a plurality of devices sharing a network resource. The service profile defines the level of data/service (e.g., bit-rate cap, data volume cap, etc.) that a device will receive from a base station and/or cell tower or other carrier network resource during a particular access period. The service profile may correspond to a data volume cap and/or bit-rate cap for Verizon subscribers, depending on the underlying service plan as well as network congestion. The service profiles within the Verizon's network identify the levels of service for each customer so that the Verizon network management system can allocate access to shared network resources, especially during periods of congestion or heavy usage. Verizon Data Plans include an allotted amount of high speed data or premium data. The service profile for a particular device or customer may be based on the data volume cap and any associated data bit-rate: 5G Nationwide / 4G LTE: 5G Nationwide requires a 5G Nationwide compatible device. Devices manufactured before 2020 are not 5G Nationwide compatible. You will receive 4G LTE when 5G Nationwide isn't available. During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic (only after 50 GB/mo of 5G Nationwide or 4G LTE data on Play More Unlimited 5G UW, Do More Unlimited 5G UW and Get More Unlimited 5G UW). Unlimited Mobile Hotspot available on Play More, Do More and Get More Unlimited 5G UW plans. Mobile Hotspot speeds reduced to 600 Kbps (only after 15 GB/mo 5G Nationwide/4G LTE on Play More and Do More Unlimited 5G UW plans and after 30 GB/mo on the Get More Unlimited 5G UW Plan). Using Mobile Hotspot counts toward your 50 GB monthly 5G Nationwide/4G LTE plan allocation. Domestic data roaming at 2G speeds; int'l data reduced to 2G speeds after 512 MB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. 720p HD Video Streaming available on smartphones for Play More, Do More and Get More Unlimited 5G UW plans (must be turned on by customer in My Verizon online, the My Verizon App or by calling customer service); otherwise user will receive SD Video Streaming. SD (480p) Video Streaming on Start Unlimited. Important Plan Information (hereinafter "**IPI**") available at https://www.verizonwireless.com/support/important-planinformation/ (last visited Nov. 1, 2021)*;see also* VZW Plans at 2-3.

Verizon explains that certain Data Plans (such as Start Unlimited and Just Kids) may receive lower priority relative to other customers. To that end, customers with these Data Plans have associated restrictions in their service profile (which is necessarily received by the Verizon network to be processed) defining their data volume allotment and/or available data bit-rates for a given time period when accessing the Verizon network.



Start Unlimited

Unlimited talk, text & data with no overage charges.

$35 Per line per month. Plus taxes & fees.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Plan perks

Disney+ for 6 months on us

discovery+ for 6 months on us

Apple Arcade for 6 months on us

Google Play Pass for 6 months on us

Apple Music for 6 months on us

Play More Unlimited

Shows, movies & sports, plus Premium Network Access.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Do More Unlimited

Premium data, cloud storage and plan discounts.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Get More Unlimited

Our best features, plus more music & entertainment.

$55 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 30 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Just Kids

Manage screen time, filter content & track location.

$35 Per line per month plus taxes & fees. Requires one line on Unlimited.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited data at 5Mbps

Unlimited 5G Nationwide and 4G LTE data at a maximum speed of 5Mbps – good for everyday usage, like browsing the web, social media, and checking email. 5G access requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited Talk & Text up to 20 contacts

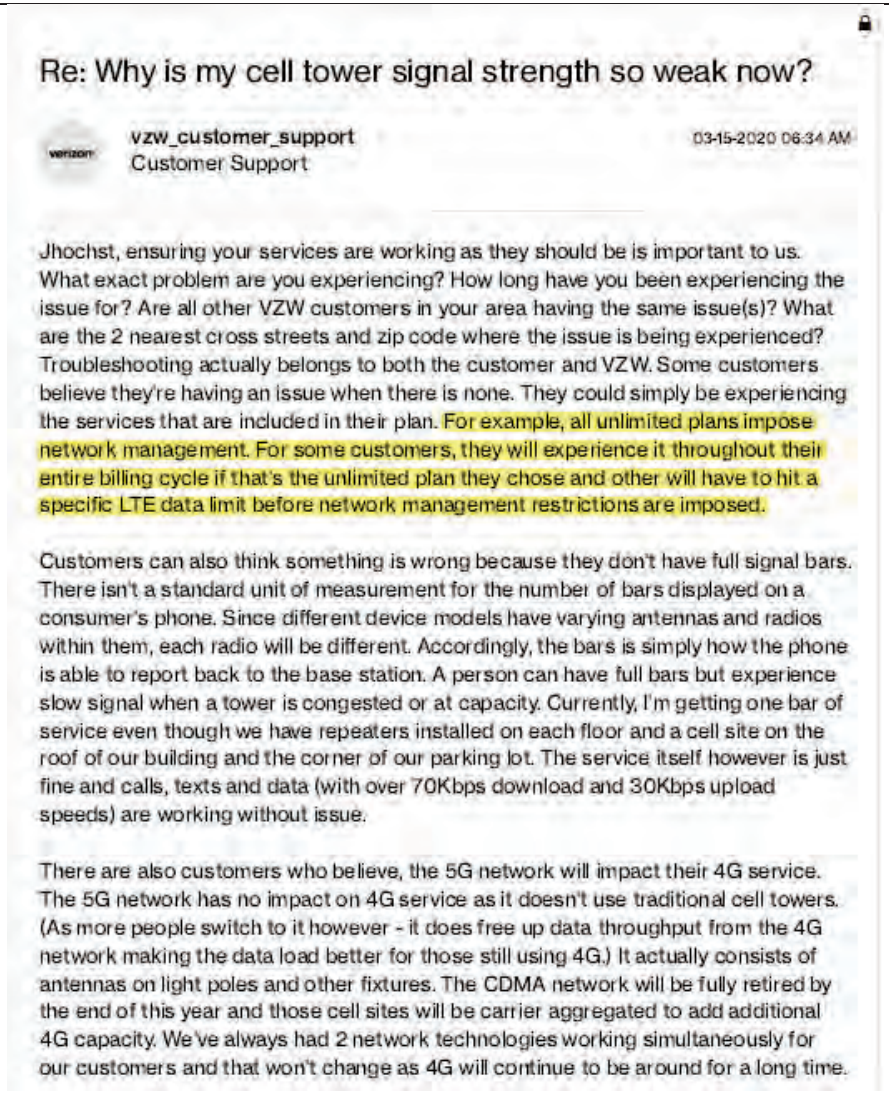
Talk and text as much (or as little) as you want to 20 contacts.

Plan perks

Parental Controls & location tracking up to 20 contacts

See, e.g., https://www.verizon.com/plans/unlimited/ (last visited Dec. 14, 2021).

Verizon also explains that "network management restrictions" conveyed as part of the service profile are used to make prioritization decisions during periods of network congestion:



Re: Why is my cell tower signal strength so weak now?

vzw_customer_support
Customer Support

03-15-2020 06:34 AM

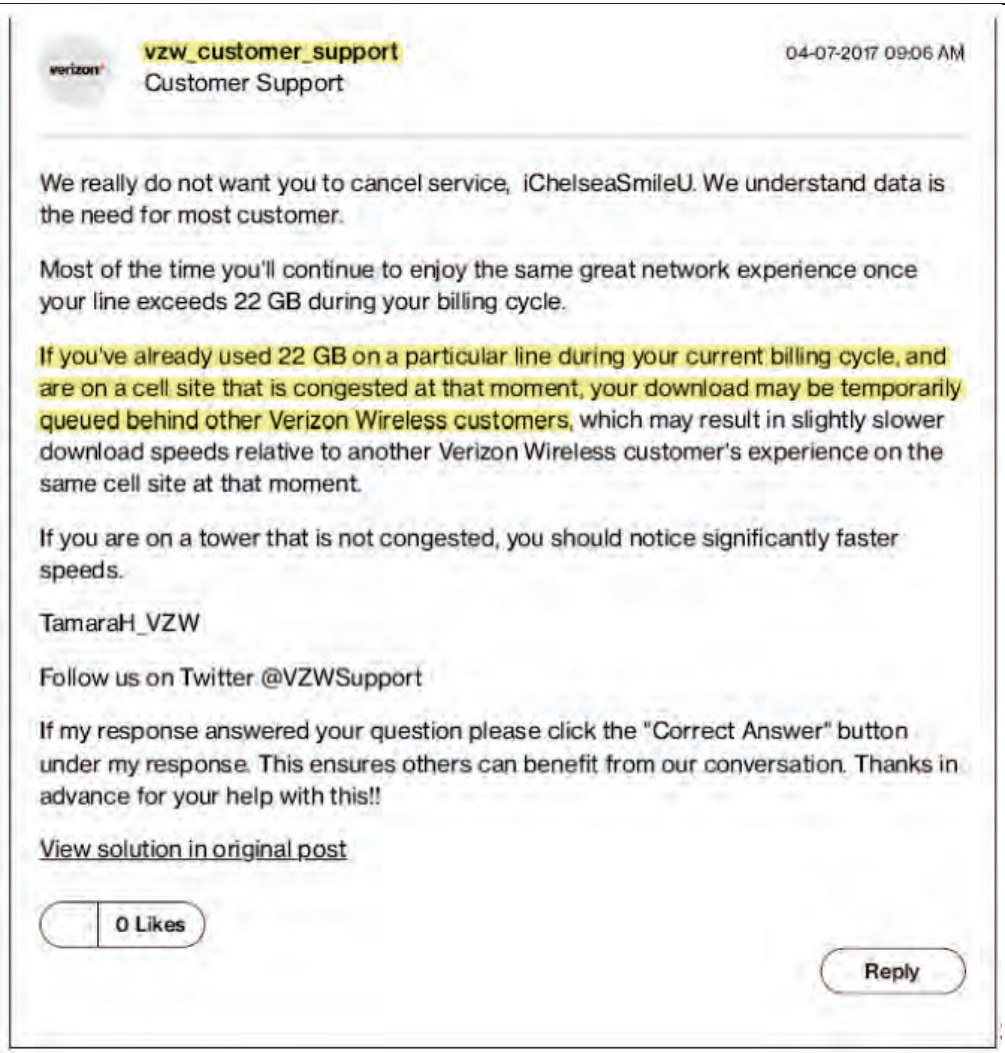
Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed.

Customers can also think something is wrong because they don't have full signal bars. There isn't a standard unit of measurement for the number of bars displayed on a consumer's phone. Since different device models have varying antennas and radios within them, each radio will be different. Accordingly, the bars is simply how the phone is able to report back to the base station. A person can have full bars but experience slow signal when a tower is congested or at capacity. Currently, I'm getting one bar of service even though we have repeaters installed on each floor and a cell site on the roof of our building and the corner of our parking lot. The service itself however is just fine and calls, texts and data (with over 70Kbps download and 30Kbps upload speeds) are working without issue.

There are also customers who believe, the 5G network will impact their 4G service. The 5G network has no impact on 4G service as it doesn't use traditional cell towers. (As more people switch to it however - it does free up data throughput from the 4G network making the data load better for those still using 4G.) It actually consists of antennas on light poles and other fixtures. The CDMA network will be fully retired by the end of this year and those cell sites will be carrier aggregated to add additional 4G capacity. We've always had 2 network technologies working simultaneously for our customers and that won't change as 4G will continue to be around for a long time.

See https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).

	On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4.



vzw_customer_support
Customer Support

04-07-2017 09:06 AM

We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer.

Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle.

If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment.

If you are on a tower that is not congested, you should notice significantly faster speeds.

TamaraH_VZW

Follow us on Twitter @VZWSupport

If my response answered your question please click the "Correct Answer" button under my response. This ensures others can benefit from our conversation. Thanks in advance for your help with this!!

View solution in original post

0 Likes

Reply

https://community.verizon.com/t5/Verizon-Wireless-Services/Is-data-prioritization-supposed-to-make-your-dataplan-basically/td-p/995275 (last visited Nov. 1, 2021).

The 3GPP Standards describe the use of the PCRF and other network elements to transmit and receive information that affect the provision of services to Verizon UEs. For instance, the dynamic PCC Rule, PCC decision, PCC rule, QoS rule, and service data flow template all relate to information that is transmitted and received within an operator network to implement policy charging and control.

> **PCC decision:** A decision consists of PCC rules and IP-CAN bearer attributes and is provided by the PCRF to the PCEF for policy and charging control and, for PCEF enhanced with ADC, application detection and control.
>
> **PCC rule:** A set of information enabling the detection of a service data flow and providing parameters for policy control and/or charging control and, for PCEF enhanced with ADC, for application detection and control.
>
> **policy control:** The process whereby the PCRF indicates to the PCEF how to control the IP-CAN bearer. Policy control includes QoS control and/or gating control.
>
> **QoS rule:** A set of information enabling the detection of a service data flow and defining its associated QoS parameters.
>
> **service data flow template:** The set of service data flow filters in a PCC Rule or an application identifier in a PCC rule referring to an application detection filter, required for defining a service data flow.

3GPP TS 23.203 at 17-18.

PCRF decisions are based in part on service profile information. "The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF. . . . The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information. The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile." 3GPP TS 23.203 at 71. "The PCRF may check that the service information provided by the AF is consistent with both the operator defined policy rules and the related subscription information as received from the SPR during IP-CAN session establishment before storing the service information." *Id.* at 72. "The PCRF authorizes QoS resources. The PCRF uses the service information received from the AF (e.g., SDP information or other available application information) and/or the subscription information received from the SPR to calculate the proper QoS authorization (QoS class identifier, bitrates)." *Id.* "The PCRF may use the subscription information as basis for the policy and charging control decisions." *Id.*

> 6.2.1.2 Subscription information management in the PCRF
>
> The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination.
>
> The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted.

3GPP TS 23.203 at 79.

The PCEF also participates in the policy enforcement decisions based on information from the PCRF and other network elements.

> 6.2.2 Policy and Charging Enforcement Function (PCEF)
>
> 6.2.2.1 General
>
> The PCEF encompasses service data flow detection, policy enforcement and flow based charging functionalities.
>
> This functional entity is located at the Gateway (e.g. GGSN in the GPRS case, and PDG in the WLAN case). It provides service data flow detection, user plane traffic handling, triggering control plane session management (where the IP-CAN permits), QoS handling, and service data flow measurement as well as online and offline charging interactions.
>
> A PCEF shall ensure that an IP packet, which is discarded at the PCEF as a result from PCC rule enforcement or flow based charging, is neither reported for offline charging nor cause credit consumption for online charging.

3GPP TS 23.203 at 83.

	The PCEF is enforcing the Policy Control as indicated by the PCRF in two different ways: - Gate enforcement. The PCEF shall allow a service data flow, which is subject to policy control, to pass through the PCEF if and only if the corresponding gate is open; - QoS enforcement: - QoS class identifier correspondence with IP-CAN specific QoS attributes. The PCEF shall be able to convert a QoS class identifier value to IP-CAN specific QoS attribute values and determine the QoS class identifier value from a set of IP-CAN specific QoS attribute values. - PCC rule QoS enforcement. The PCEF shall enforce the authorized QoS of a service data flow according to the active PCC rule (e.g. to enforce uplink DSCP marking). - IP-CAN bearer QoS enforcement. The PCEF controls the QoS that is provided to a combined set of service data flows. The policy enforcement function ensures that the resources which can be used by an authorized set of service data flows are within the "authorized resources" specified via the Gx interface by "authorized QoS". The authorized QoS provides an upper bound on the resources that can be reserved (GBR) or allocated (MBR) for the IP-CAN bearer. The authorized QoS information is mapped by the PCEF to IP-CAN specific QoS attributes. During IP-CAN bearer QoS enforcement, if packet filters are provided to the UE, the PCEF shall provide packet filters with the same content as that in the SDF template filters received over the Gx interface. 3GPP TS 23.203 at 84.

The PCEF is enforcing the charging control in the following way:

- For a service data flow (defined by an active PCC rule) that is subject to charging control, the PCEF shall allow the service data flow to pass through the PCEF if and only if there is a corresponding active PCC rule with and, for online charging, the OCS has authorized credit for the charging key. The PCEF may let a service data flow pass through the PCEF during the course of the credit re-authorization procedure.

For a service data flow (defined by an active PCC rule) that is subject to both Policy Control and Charging Control, the PCEF shall allow the service data flow to pass through the PCEF if and only if the right conditions from both policy control and charging control happen. I.e. the corresponding gate is open and in case of online charging the OCS has authorized credit for its charging key.

For a service data flow (defined by an active PCC rule) that is subject to policy control only and not charging control, the PCEF shall allow the service data flow to pass through the PCEF if and only if the conditions for policy control are met.

A PCEF may be served by one or more PCRF nodes. The PCEF shall contact the appropriate PCRF based on the packet data network (PDN) connected to, together with, a UE identity information (if available, and which may be IP-CAN specific). It shall be possible to ensure that the same PCRF is contacted for a specific UE irrespective of the IP-CAN used.

3GPP TS 23.203 at 84.

Each session may be associated with a PCC rule that includes specified QoS parameters derived from service profile information.

For the authorization of a PCC rule the PCRF shall take into account the IP-CAN specific restrictions and other information available to the PCRF. Each PCC rule receives a set of QoS parameters that can be supported by the IP-CAN. The authorization of a PCC rule associated with an emergency service and Restricted Local Operator Services shall be supported without subscription information (e.g. information stored in the SPR). The PCRF shall apply policies configured for the emergency service and Restricted Local Operator Services.

When both a Gx and associated Gxx interface(s) exist for an IP-CAN session, the PCRF shall generate QoS rules for all the authorized PCC rules in this step. The PCRF shall ensure consistency between the QoS rules and PCC rules authorized for the same service data flow when QoS rules are derived from corresponding PCC rules.

When flow mobility applies for the IP-CAN Session, one IP-CAN session may be associated to multiple Gateway Control Sessions with separate BBRFs. In this case, the PCRF shall provision QoS rules only to the appropriate BBERF based on IP flow mobility routing rules received from the PCEF.

3GPP TS 23.203 at 38.

The 3GPP Standards describe that a PCRF can maintain UE-specific policy information that corresponds to each of a plurality of devices sharing a network resource. For example, the PCRF can act based on inputs that have UE identity information, such as IMSIs, for IP-CAN sessions between a UE and an operator's IP services network.

> **IP-CAN session:** The association between a UE and an IP network. The association is identified by one IPv4 and/or an IPv6 prefix together with UE identity information, if available, and a PDN represented by a PDN ID (e.g. an APN). An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as UE IP addresses/prefix are established and announced to the IP network.

3GPP TS 23.203 at 17.

> 6.4 IP-CAN bearer and IP-CAN session related policy information
>
> The purpose of the IP-CAN bearer and IP-CAN session related policy information is to provide policy and charging control related information that is applicable to a single IP-CAN bearer or the whole IP-CAN session respectively. The PCRF provides the IP-CAN bearer and IP-CAN session related policy information to the PCEF and BBERF (if applicable) using the PCC rule and QoS rule (if applicable) provision procedure. The IP-CAN bearer related policy information may be provided together with rules or separately.
>
> Table 6.4 lists the PCC related IP-CAN bearer and IP-CAN session related policy information.

3GPP TS 23.203 at 108; *see also id.* at 109 (listing attributes in Table 6.4).

> 6.4b APN related policy information
>
> The purpose of the APN related policy information is to provide policy and charging control related information that is applicable to all IP-CAN sessions of a UE to the same APN. The PCRF provides APN related policy information to the PCEF using the PCC provision procedure together with PCC rules or separately.
>
> Table 6.4b-1 lists the applicable PCC specific APN related policy information.

3GPP TS 23.203 at 111; *see also id.* at 112 (listing attributes in Table 6.4b-1).

	Service profile information is also used to implement QoS controls within the operator network. 4.3.3 QoS control 4.3.3.1 QoS control at service data flow level It shall be possible to apply QoS control on a per service data flow basis in the PCEF. QoS control per service data flow allows the PCC architecture to provide the PCEF with the authorized QoS to be enforced for each specific service data flow. Criteria such as the QoS subscription information may be used together with policy rules such as, service-based, subscription-based, or predefined PCRF internal policies to derive the authorized QoS to be enforced for a service data flow. It shall be possible to apply multiple PCC rules, without application provided information, using different authorised QoS within a single IP-CAN session and within the limits of the Subscribed QoS profile. 3GPP TS 23.203 at 24.

	4.3.3.2 QoS control at IP-CAN bearer level It shall be possible for the PCC architecture to support control of QoS reservation procedures (UE-initiated or network-initiated) for IP-CANs that support such procedures for its IP-CAN bearers in the PCEF or the BBERF, if applicable. It shall be possible to determine the QoS to be applied in QoS reservation procedures (QoS control) based on the authorised QoS of the service data flows that are applicable to the IP-CAN bearer and on criteria such as the QoS subscription information, service based policies, and/or predefined PCRF internal policies. Details of QoS reservation procedures are IP-CAN specific and therefore, the control of these procedures is described in Annex A and Annex D. It shall be possible for the PCC architecture to support control of QoS for the packet traffic of IP-CANs. The PCC architecture shall be able to provide policy control in the presence of NAT devices. This may be accomplished by providing appropriate address and port information to the PCRF. The enforcement of the control for QoS reservation procedures for an IP-CAN bearer shall allow for a downgrading or an upgrading of the requested QoS as part of a UE-initiated IP-CAN bearer establishment and modification. The PCC architecture shall be able to provide a mechanism to initiate IP-CAN bearer establishment and modification (for IP-CANs that support such procedures for its bearers) as part of the QoS control. The IP-CAN shall prevent cyclic QoS upgrade attempts due to failed QoS upgrades. NOTE: These measures are IP-CAN specific. The PCC architecture shall be able to handle IP-CAN bearers that require a guaranteed bitrate (GBR bearers) and IP-CAN bearers for which there is no guaranteed bitrate (non-GBR bearers). 3GPP TS 23.203 at 24.

The 3GPP Standards also describe the use of a PCRF to maintain service profile information based on UE-specific subscriber information received from a Subscriber Profile Repository (SPR) or User Data Repository (UDR). *See* 3GPP TS 23.203 at 28-29 (illustrating different architecture diagrams using SPR and/or UDR).

> 5.2.3 Reference points to subscriber databases
>
> 5.2.3.1 Sp reference point
>
> The Sp reference point lies between the SPR and the PCRF.
>
> The Sp reference point allows the PCRF to request subscription information related to the IP-CAN transport level policies from the SPR based on a subscriber ID, a PDN identifier and possible further IP-CAN session attributes, see Annex A and Annex D. For example, the subscriber ID can be IMSI. The reference point allows the SPR to notify the PCRF when the subscription information has been changed if the PCRF has requested such notifications. The SPR shall stop sending the updated subscription information when a cancellation notification request has been received from the PCRF.
>
> NOTE: The details associated with the Sp reference point are not specified in this Release.
>
> 5.2.3.2 Ud reference point
>
> The Ud reference point resides between the UDR and the PCRF, acting as an Application Frontend as defined in TS 23.335 [25]. It is used by the PCRF to access PCC related subscription data when stored in the UDR.
>
> The details for this reference point are described in TS 23.335 [25] and TS 29.335 [26].

3GPP TS 23.203 at 32.

The SPR is described in Section 6.2.4 of 3GPP TS 23.203.

> 6.2.4 Subscription Profile Repository (SPR)
>
> The SPR logical entity contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF. The SPR may be combined with or distributed across other databases in the operator's network, but those functional elements and their requirements for the SPR are out of scope of this document.

3GPP TS 23.203 at 94.

The SPR may provide the following subscription profile information (per PDN, which is identified by the PDN identifier):

- Subscriber's allowed services;
- For each allowed service, a pre-emption priority;
- Information on subscriber's allowed QoS, including the Subscribed Guaranteed Bandwidth QoS;
- Subscriber's charging related information (e.g. location information relevant for charging);
- Subscriber's User CSG Information reporting rules;
- List of Presence Reporting Area identifiers and optionally the elements for one or more of the Presence Reporting Areas;
- Subscriber category;
- Subscriber's usage monitoring related information;
- MPS EPS Priority and MPS Priority Level;
- IMS Signalling Priority;
- Subscriber's profile configuration indicating whether application detection and control can be enabled.
- Spending limits profile containing an indication that policy decisions are based on policy counters available at OCS that has a spending limit associated with it and optionally the list of policy counters.

3GPP TS 23.203 at 94; *see generally id.* at Section 6.2.4.

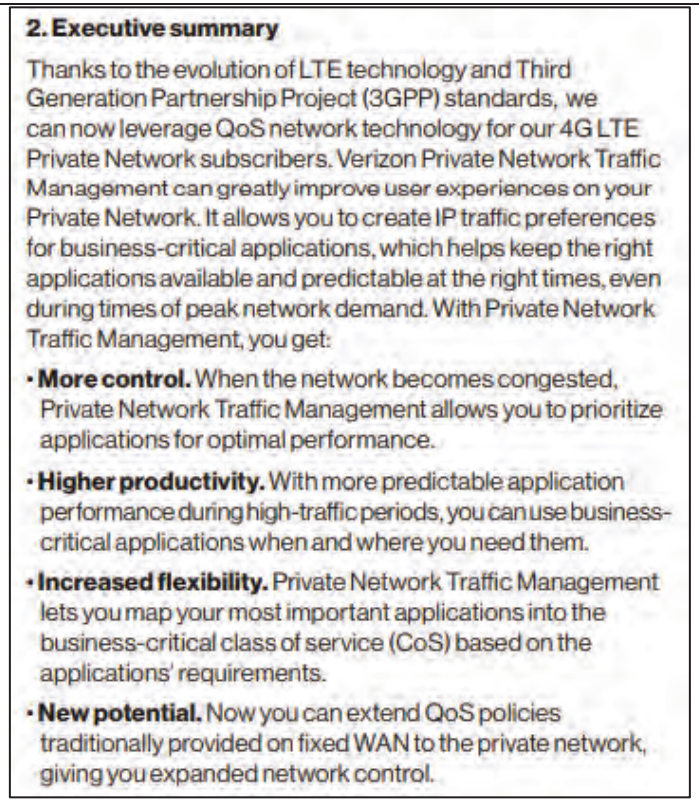
The User Data Repository also maintain subscriber-based information similar to that of the SPR.

6.2.8 User Data Repository (UDR)

The UDR is a functional entity that acts as a single logical repository storing user data. As such it may contain all subscriber/subscription related information needed by the PCRF. In deployment scenarios where the UDR is used it replaces the SPR. The UDR provides a unique reference point to fetch these subscriber/subscription data. This reference point is named Ud. More information on the UDR can be found in TS 23.335 [25].

3GPP TS 23.203 at 96.

	Verizon discloses that it uses policy control parameters defined by 3GPP and the Internet Engineering Task Force to govern services provided to a UE. Verizon's Response Our tailored network design includes Traffic Management that enables application differentiation and Quality of Service (QoS) over the LTE Private Network using standards-based IP packet marking. Verizon's Private Network service transports a multitude of data applications, including Voice over IP (VoIP), video and best effort applications. When there is contention for network resources, mission critical applications (i.e., VoIP) are competing with best effort applications (i.e., email) for network resources, so customers' mission critical applications may experience performance degradation (e.g., difficulty accessing Verizon's LTE network resources, variable download/upload speeds, etc.). Today, Verizon offers network priority and preemption that allows the assignment of QoS for user profiles using the standard service control parameters defined by 3GPP and the Internet Engineering Task Force, including Access Class, Quality Class Indicator (QCI), Allocation and Retention Priority (ARP), and Differentiated Service (Diff Serve). While our network RAN deployment ensures coverage 24 hours a day, 7 days a week, and 365 days a year. Verizon Network Technology Questionnaire, at 52.



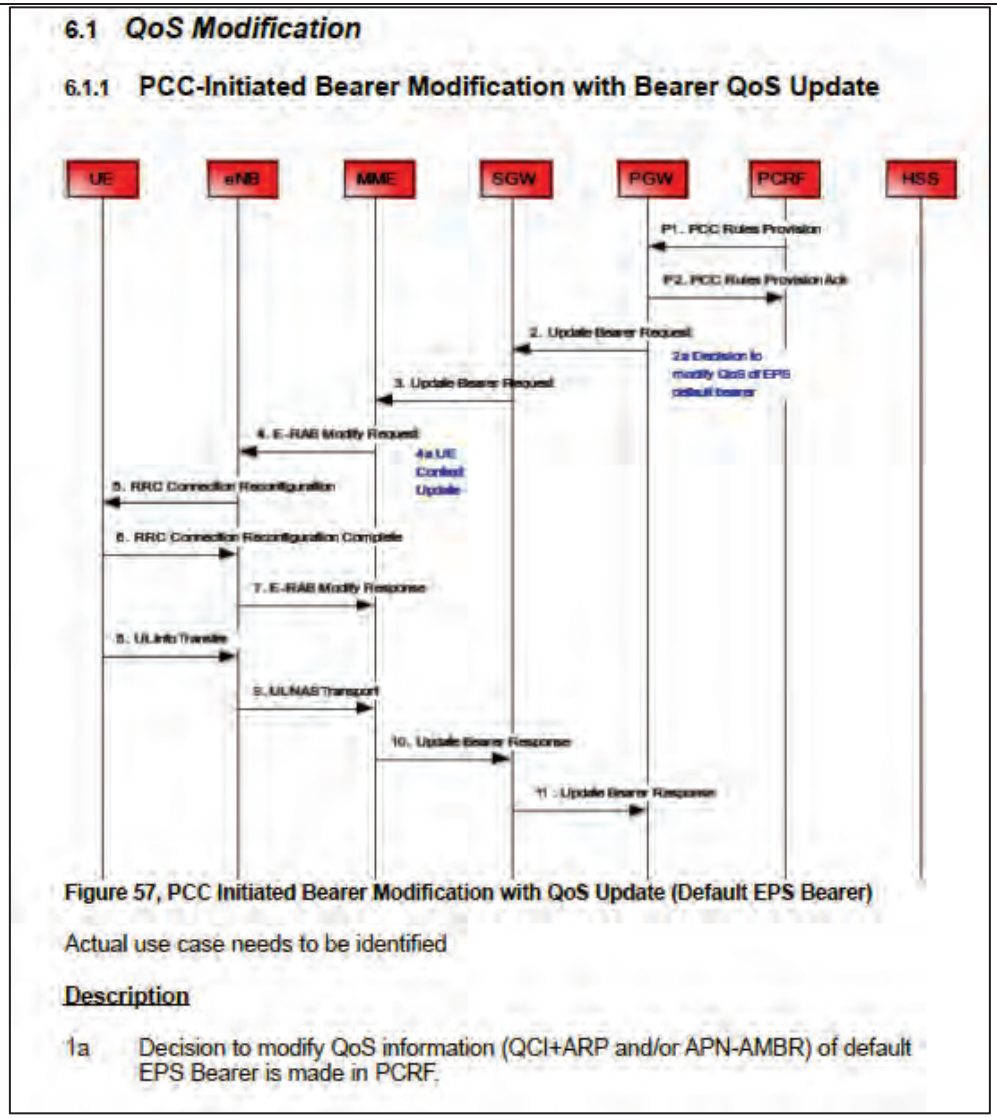
2. Executive summary

Thanks to the evolution of LTE technology and Third Generation Partnership Project (3GPP) standards, we can now leverage QoS network technology for our 4G LTE Private Network subscribers. Verizon Private Network Traffic Management can greatly improve user experiences on your Private Network. It allows you to create IP traffic preferences for business-critical applications, which helps keep the right applications available and predictable at the right times, even during times of peak network demand. With Private Network Traffic Management, you get:

- **More control.** When the network becomes congested, Private Network Traffic Management allows you to prioritize applications for optimal performance.
- **Higher productivity.** With more predictable application performance during high-traffic periods, you can use business-critical applications when and where you need them.
- **Increased flexibility.** Private Network Traffic Management lets you map your most important applications into the business-critical class of service (CoS) based on the applications' requirements.
- **New potential.** Now you can extend QoS policies traditionally provided on fixed WAN to the private network, giving you expanded network control.

Verizon Private Network Traffic Management at 2.

For example, an engineering document authored by Verizon and Ericsson shows standard PCC parameters that are received and transmitted at the PCRF and P-GW (including the PCEF) during various call flows, including when the Accused Wireless Network establishes and modifies IP-CAN sessions between an IPv6 network and a UE:



Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 264.

		1. PCRF sends PCC rules to P-GW with PCC Rules Provision message RAR (APN-AMBR and/or QoS rule) and P-GW acknowledges this with PCC Rules Ack message RAA (QoS Rule Report) 2a PGW uses the received QoS information to determine to update EPS default bearer with received QoS and/or APN-AMBR. 2. PGW sends **Update Bearer Request** (IMSI, Bearer Contexts (bearer level QoS is included inside this IE), GRE Key, APN-AMBR) message to SGW 3. SGW sends **Update Bearer Request** (IMSI, Bearer Contexts (bearer level QoS is included inside this IE), GRE Key, APN-AMBR) message to MME 3a UE-AMBR is updated in case APN-AMBR is modified. 3. MME builds a **Modify EPS Bearer Context Request** (Protocol Discriminator, EPS Bearer Identity, Procedure Transaction Identity, Modify EPS Bearer Context Request message Identity, TFT and/or New QoS and/or APN-AMBR) message and sends it as part of E-RAB Modify Request (Message Type, MME UE S1AP ID, eNB UE S1AP ID, E-RAB to be modified list, NAS-PDU (Modify EPS Bearer Context Request)) message to eNB. 4.-5. eNB maps modified EPS Bearer QoS to Radio Bearer QoS. It then signals **RRC Connection Reconfiguration** (Radio Resource Configuration, NAS Info (Modify EPS Bearer Context Request)) message to UE. UE stores new EPS QoS and acknowledges the radio bearer modification with **RRC Connection Reconfiguration Complete**. 6. eNB acknowledges the bearer modification to MME with a **E-RAB Modify Response** (Message Type, MME UE S1AP ID, eNB UE S1AP ID) message. With this message, eNB indicates whether the requested EPS Bearer QoS modification could be executed or not. 7. UE NAS layer builds a NAS level **Modify EPS Bearer Context Accept** (Protocol Discriminator, EPS Bearer Identity, Procedure Transaction Identity, Modify EPS Bearer Context Accept message Identity) message and sends it inside **UL Information Transfer** (Modify EPS Bearer Context Accept) message to eNB. 8. eNB sends an **Uplink NAS Transport** (Modify EPS Bearer Context Accept) message to MME. 9. Upon reception of Modify EPS Bearer Context Accept message MME acknowledges the bearer modification to S-GW by sending an **Update Bearer Response** (Cause, Bearer Contexts) message. 7. The SGW acknowledges the bearer modification to PGW by sending an **Update Bearer Response** (Cause, Bearer Contexts) message.

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 265.

15 **PCEF-Initiated IP-CAN Session Termination**
If there is no local static policy, the PCEF (PGW) sends a **CC Request (CCR) message with CC-Request-Type AVP set to TERMINATION_REQUEST**.

. . .

S1 If the PCRF had subscribed to notifications from the SPR and this is the last PDN connection for the UE then the PCRF updates the SPR to indicate IP-CAN session termination (= cancel subscription to profile updates) by sending an **Sh:SNR (subscription-request-type=unsubscribe).**

S2 The HSS responds with a confirming **SNA (Result-Code).**

16 The PCRF responds with **CC Answer (CCA)** message.

17 The PGW responds with **Delete Session Response (Cause, Recovery** (if contacting peer for the first time)).
SGW counter S5S8DeleteSessionRespAccRcvd is incremented.
The SGW forwards the message to the MME.
SGW counter S11S4DeleteSessionRespAccSent is incremented.

18. Update Location Answer
The HSS replies with **Update Location Answer (Result, ULA-Flags, Subscription Data [MSISDN, APN-Configuration list [MIP6-Agent-Info], MSISDN, PDN Type [IPv6]** (for IMS PDN))) [TS 29.272].
ULA-Flags and Subscription Data shall be present when the Result is Success. The Subscription Data includes the profile for all the subscribed APNs that the UE is allowed to connect to.

19. Create Session Request
The MME sends a **Create Session Request (IMSI, MSISDN (if available from HSS), MEI, ULI, Serving Network, RAT Type, Indication Flags, Sender F-TEID for C-plane, PGW Address for C-plane or PMIP, APN, Selection Mode, PDN Type [IPv6], PAA, Maximum APN Restriction, APN-AMBR, PCO (IPv6 DNS and P-CSCF addresses), Bearer Contexts [EBI, Bearer QoS, Charging Characteristics])** [TS 29.274]. The GTP-timer S11_T3-ResponseCreateSession specifies the maximum waiting time for a response to a Create Session Request message. S11_N3-RequestsCreateSession specifies the maximum number of attempts to send a Create Session Request message. The arithmetic product of S11_T3-ResponseCreateSession and S11_N3-RequestsCreateSession should be lesser than 30 seconds.

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 51-52.

A1 The P-GW sends **AAR {Session-ID, PGW-FQDN, IMSI-NAI , APN, [RAT-Type] }** to the 3GPP AAA to authorize the APN for the subscriber and to update P-GW address on the HSS for the APN.

A2 The 3GPP AAA updates the HSS with the P-GW address for the APN, retrieves Subscriber-APN profiles from the HSS

A3 The 3GPP AAA sends the Subscriber-APN profiles from the HSS for the UE, Adds access specific information to the Subscriber-APN profiles and returns that to the P-GW in a **AAA { Session-ID , Subscriber-APN-Profile }**. The subscriber Profile contains default APN profile and a list of authorized APN profiles. The server-name AVP in the Subscriber-APN profile carries the P-CSCF FQDN. PGW performs DNS query to resolve P-CSCF FQDN prior to returning the P-CSCF addresses in step C.3.

C.2.1 IP-CAN Session Establishment Procedure

The PCEF sends a **CC-Request** (CCR) Command with CC-Request-Type set to INITIAL_REQUEST. The following attributes shall be present: Default-EPS-Bearer-QoS, AN-GW-Address, Called-Station-Id (APN-Name), [Event-Report-Indication], 3GPP-User-Location-Info, IP-CAN Type, RAT Type, Framed-IPv6-Prefix, Subscription-Id (IMSI), [Access-network-Charging-identifier-Gx], [Offline], Network-Request-Support , [QoS-Information] User-Equipment-Info and base credit control AVP's (See 5.6.2 in TS 29.212). The subscribed APN-AMBR is included in the QoS-information AVP

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 53.

S3/4 **PCRF interaction with HSS/SPR**
The PCRF downloads (and caches) user profile (by sending an Sh:UDR (User-Identity, Service-Indication, Data-Reference) and receiving an Sh:UDA (Result-Code, User-Data)).

The PCRF may subscribe to profile update notification (by sending an Sh:SNR ((User-Identity, Service-Indication, Data-Reference)) and receiving an Sh:SNA (Result-Code).

C.2.2 On receiving a CCR the PCRF shall sends **CC-Answer** (CCA) Command to install the PCC rules and event triggers. CCA includes the following AVPs: Default-EPS-Bearer-QoS, Bearer-Control-Mode, Event-trigger (subscribe to user location change (eCGI or/and TAI (Event-Trigger=USER_LOCATION_CHANGE (13)), subscribe to serving gateway change (Event-Trigger=AN_GW_CHANGE (21)), subscribe to OUT_OF_CREDIT (15), subscribe to REALLOCATION_OF_CREDIT (16)), subscribe to IP-CAN_CHANGE (7), subscribe to RAT_CHANGE (2), subscribe to PLMN_CHANGE (4), subscribe to QOS_CHANGE (1), subscribe to DEFAULT_EPS_BEARER_QOS_CHANGE (20)]], [QoS-information], and Charging-rule-install are subject to use case. The QoS-Information AVP contains authorized APN-AMBR (APN-AMBR-UL and APN-AMBR-DL). The Charging-rule-install will include the rule required to create the dedicated bearer for SIP signaling.

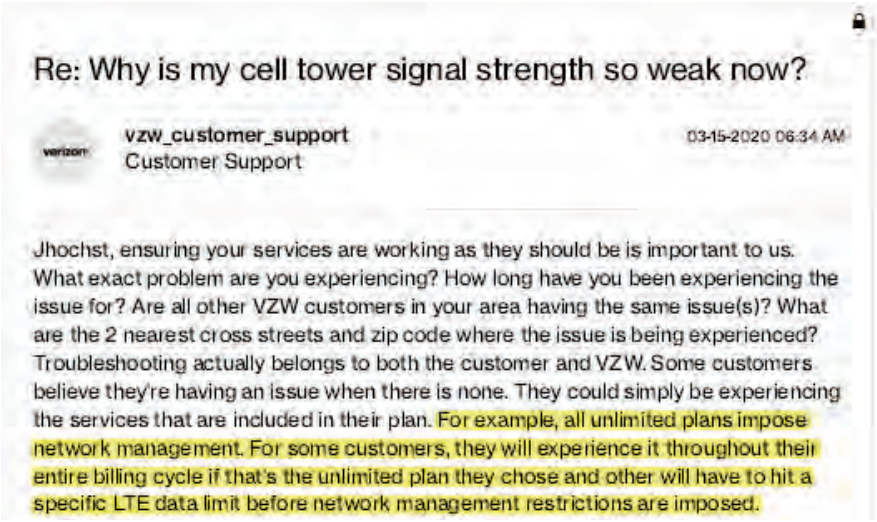
Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 53-54.

In addition to the use of 4G PCC architecture referenced above, the Verizon operator network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving a service profile for each of a plurality of devices sharing a network resource.

Several network functions described in the 3GPP Standards transmit and receive information elements to enforce policy decisions for services provided to UEs that access Verizon's 5G network, such as the Policy Control Function (PCF), Access and Mobility Management Function (AMF), Session Management Function (SMF), Application Function (AF), Charging Function (CHF), Unified Data Repository (UDR), Network Exposure Functionality (NEF), and Network Data Analytics Function (NWDAF). *See* 3GPP TS 23.503 at 17; *see also*, *e.g.*, 3GPP TS 23.503 at 9 (defining dynamic PCC rule, PCC decision, PCC rule, policy control, and service data flow template for 5G systems); *id.* at 17-20 (5G reference architecture); *id.* at 4748 (QoS parameters in service data flow template); *id.* at 60-62 (Policy Control Function); *id.* at 63-66 (input for PCC decisions including service profile information); *id.* at 66-69 (Policy control subscription information management); *id.* at 70-72 (Session Management Function); *id.* at 90-94 (PDU

	Session related policy information); *id.* at 96-97 (Access and mobility related policy information); *id.* at 97 (UE access selection and PDU Session selection related policy information); *id.* at 15 (QoS control requirements at service data flow level, QoS flow level, and PDU Session level). On information and belief, the service profile information is provided by the Verizon network management systems, including but not limited to the Verizon operations support systems (OSS) and business support systems (BSS) used to manage customer records, billing records, network services, and network operation. Examples of these systems are detailed below. *See* Claims 10-17 and 37-40. On information and belief, Verizon's OSS/BSS systems provide policy control (including 3GPP Policy and Charging Rules Function (PCRF) and Policy Control Function (PCF)) consistent with TS23.303, which includes the establishment of IP-CAN sessions, Usage Monitoring Control (Section 4.4), an architecture that correlates to the Reference Architecture (identified in Section 5.1), QoS control (Section 4.3.3), a GX reference point (Section 5.2.2), reference points to subscriber databases (Section 5.2.3), a Policy Control and Charging Rules Function (PCRF) (Section 6.2.1.0), subscription information management in the PCRF (Section 6.2.1.2), a subscription profile repository (SPR), and a user data repository (UDR).
1[C] receiving a billing profile for each of said plurality of devices;	Verizon's implementation of dynamic allocation of network resources includes performing the step of receiving a billing profile for each of said plurality of devices. The billing profile includes any billing parameter that regulates rating or charging or both of traffic to and from the device. For example, the billing profile may include a rate or charge that each customer pays for accessing the Verizon Services and/or an identification of current network usage for a given billing cycle, such as the amount of premium or high-speed data used or the amount of data used as a high-speed mobile hotspot for a given month. These examples are non-limiting, as other information regarding billing, billing history, usage and usage history may also form part of the billing profile.

	Implementing Verizon's Broadband Internet Access Services includes receiving a billing profile for users or user devices attempting to access the network to facilitate Verizon's prioritization scheme: **Does Verizon Wireless take any steps to manage the flow of data on the network used for Broadband Internet Access Services?** Verizon Wireless strives to provide customers the best experience when using our network, which is a shared resource among tens of millions of customers. Verizon Wireless has used sound engineering principles in the design and operation of its broadband network to ensure a good user experience for all customers. An individual user's experience will vary depending upon many factors, including the plan they select, the network (5G Ultra Wideband, 5G Nationwide, 4G LTE, or 3G Ev-DO) the customer is using, and the device in use. See, e.g., BSI at 3; see also NM at 2. The billing profile may vary based on the type of Plan associated with a Verizon customer: 5G Nationwide / 4G LTE: 5G Nationwide requires a 5G Nationwide compatible device. Devices manufactured before 2020 are not 5G Nationwide compatible. You will receive 4G LTE when 5G Nationwide isn't available. During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic (only after 50 GB/mo of 5G Nationwide or 4G LTE data on Play More Unlimited 5G UW, Do More Unlimited 5G UW and Get More Unlimited 5G UW). Unlimited Mobile Hotspot available on Play More, Do More and Get More Unlimited 5G UW plans. Mobile Hotspot speeds reduced to 600 Kbps (only after 15 GB/mo 5G Nationwide/4G LTE on Play More and Do More Unlimited 5G UW plans and after 30 GB/mo on the Get More Unlimited 5G UW Plan). Using Mobile Hotspot counts toward your 50 GB monthly 5G Nationwide/4G LTE plan allocation. Domestic data roaming at 2G speeds; intl data reduced to 2G speeds after 512 MB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. 720p HD Video Streaming available on smartphones for Play More, Do More and Get More Unlimited 5G UW plans (must be turned on by customer in My Verizon online, the My Verizon App or by calling customer service); otherwise user will receive SD Video Streaming. SD (480p) Video Streaming on Start Unlimited. *See, e.g.*, IPI at 1.

	On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4. Verizon explains that certain data plans that are reduced in priority throughout the entire billing cycle, while other data plans impose restrictions only after certain conditions are met, as conveyed in a billing profile:  Re: Why is my cell tower signal strength so weak now? vzw_customer_support Customer Support 03-15-2020 06:34 AM Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed. *See* https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021). Accordingly, in order to enforce the restrictions imposed by its various Data Plans, Verizon receives a billing profile for each of said plurality of devices. The 3GPP Standards describe the use of the PCRF in Verizon's operator network and other network elements that transmit and receive UE-specific information pertaining to Verizon's subscribers.

	4.2.2 Charging models The PCC charging shall support the following charging models both for charging performed by PCEF and charging performed by TDF: - Volume based charging; - Time based charging; - Volume and time based charging; - Event based charging; - No charging. NOTE 1: The charging model - "No charging" implies that charging control is not applicable. 3GPP TS 23.203 at 21.

	The billing profile governs, in part, the manner in which charging models are built and implemented within the operator network. **4.2.2a Charging requirements** The requirements in this clause apply to both PCC rules based charging and ADC rules based charging unless exceptions are explicitly mentioned. It shall be possible to apply different rates and charging models when a user is identified to be roaming from when the user is in the home network. Furthermore, it shall be possible to apply different rates and charging models based on the location of a user, beyond the granularity of roaming. It shall be possible to apply different rates and charging models when a user consuming network services via a CSG cell or a hybrid cell according to the user CSG information. User CSG information includes CSG ID, access mode and CSG membership indication. It shall be possible to apply a separate rate to a specific service, e.g. allow the user to download a certain volume of data, reserved for the purpose of one service for free, and then continue with a rate causing a charge. It shall be possible to change the rate based on the time of day. It shall be possible to enforce per-service identified by PCC Rule/per-application identified by ADC Rule usage limits for a service data flow using online charging on a per user basis (may apply to prepaid and post-paid users). It shall be possible to apply different rates depending on the access used to carry a Service Data Flow. This applies also to a PDN connection supporting NBIFOM. It shall be possible for the online charging system to set and send the thresholds (time and/or volume based) for the amount of remaining credit to the PCEF or TDF for monitoring. In case the PCEF or TDF detects that any of the time based or volume based credit falls below the threshold, the PCEF or TDF shall send a request for credit re-authorization to the OCS with the remaining credit (time and/or volume based). 3GPP TS 23.203 at 22.

It shall be possible for the charging system to select the applicable rate based on:

- home/visited IP-CAN;
- User CSG information;
- IP-CAN bearer characteristics (e.g. QoS);
- QoS provided for the service;
- time of day;
- IP-CAN specific parameters according to Annex A.

3GPP TS 23.203 at 22.

The charging system maintains the tariff information, determining the rate based on the above input. Thus the rate may change e.g. as a result of IP-CAN session modification to change the bearer characteristics provided for a service data flow.

The charging rate or charging model applicable to a service data flow/detected application traffic may change as a result of events in the service (e.g. insertion of a paid advertisement within a user requested media stream).

The charging model applicable to a service data flow/detected application traffic may change as a result of events identified by the OCS (e.g. after having spent a certain amount of time and/or volume, the user gets to use some services for free).

The charging rate or charging model applicable to a service data flow/detected application traffic may change as a result of having used the service data flow/detected application traffic for a certain amount of time and/or volume.

For online charging, it shall be possible to apply an online charging action upon PCEF or TDF events (e.g. re-authorization upon QoS change).

3GPP TS 23.203 at 22.

The Subscription Profile Repository also contains billing profile related information.

6.2.4 Subscription Profile Repository (SPR)

The SPR logical entity contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF. The SPR may be combined with or distributed across other databases in the operator's network, but those functional elements and their requirements for the SPR are out of scope of this document.

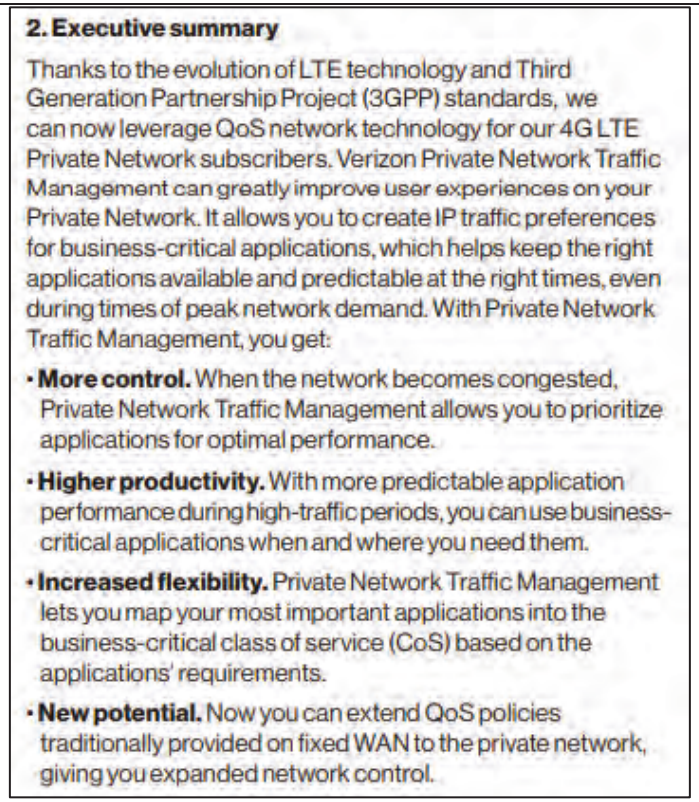
NOTE 1: The SPR's relation to existing subscriber databases is not specified in this Release.

The SPR may provide the following subscription profile information (per PDN, which is identified by the PDN identifier):

- Subscriber's allowed services;
- For each allowed service, a pre-emption priority;
- Information on subscriber's allowed QoS, including the Subscribed Guaranteed Bandwidth QoS;
- Subscriber's charging related information (e.g. location information relevant for charging);
- Subscriber's User CSG Information reporting rules;
- List of Presence Reporting Area identifiers and optionally the elements for one or more of the Presence Reporting Areas;
- Subscriber category;
- Subscriber's usage monitoring related information;
- MPS EPS Priority and MPS Priority Level;
- IMS Signalling Priority;
- Subscriber's profile configuration indicating whether application detection and control can be enabled.
- Spending limits profile containing an indication that policy decisions are based on policy counters available at OCS that has a spending limit associated with it and optionally the list of policy counters.

3GPP TS 23.203 at 94; *see also* 1[B] (describing SPR and UDR).

	Publicly available documentation reveals that Verizon uses policy control parameters defined by 3GPP and the Internet Engineering Task Force that govern services provided to a UE. For example, an engineering document authored by Verizon and Ericsson shows standard PCC parameters that are received and transmitted at the PCRF and P-GW (including the PCEF) during various call flows, including when the Accused Wireless Network establishes and modifies IP-CAN sessions between an IPv6 network and a UE. Verizon's Response Our tailored network design includes Traffic Management that enables application differentiation and Quality of Service (QoS) over the LTE Private Network using standards-based IP packet marking. Verizon's Private Network service transports a multitude of data applications, including Voice over IP (VoIP), video and best effort applications. When there is contention for network resources, mission critical applications (i.e., VoIP) are competing with best effort applications (i.e., email) for network resources, so customers' mission critical applications may experience performance degradation (e.g., difficulty accessing Verizon's LTE network resources, variable download/upload speeds, etc.). Today, Verizon offers network priority and preemption that allows the assignment of QoS for user profiles using the standard service control parameters defined by 3GPP and the Internet Engineering Task Force, including Access Class, Quality Class Indicator (QCI), Allocation and Retention Priority (ARP), and Differentiated Service (Diff Serve). While our network RAN deployment ensures coverage 24 hours a day, 7 days a week, and 365 days a year. Verizon Network Technology Questionnaire, at 52.

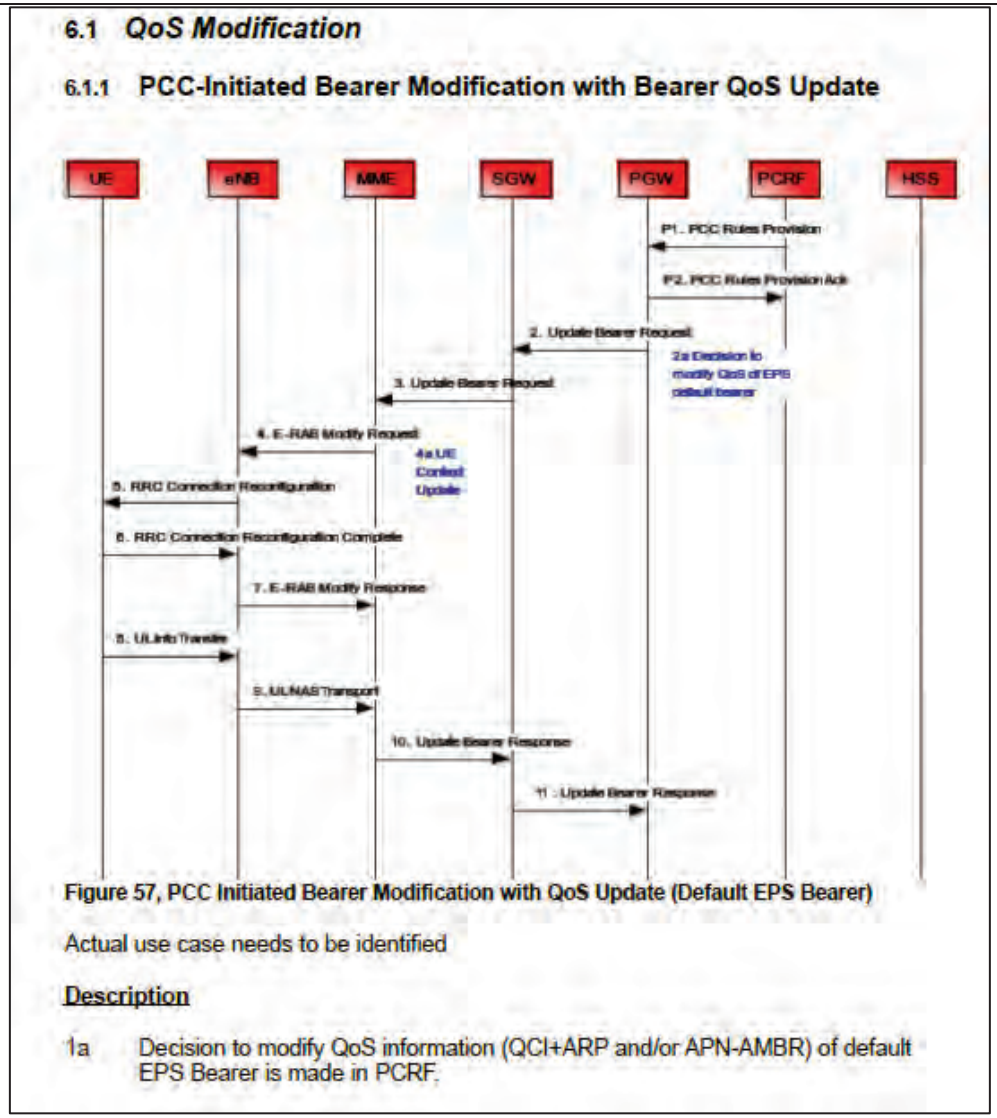


2. Executive summary

Thanks to the evolution of LTE technology and Third Generation Partnership Project (3GPP) standards, we can now leverage QoS network technology for our 4G LTE Private Network subscribers. Verizon Private Network Traffic Management can greatly improve user experiences on your Private Network. It allows you to create IP traffic preferences for business-critical applications, which helps keep the right applications available and predictable at the right times, even during times of peak network demand. With Private Network Traffic Management, you get:

- **More control.** When the network becomes congested, Private Network Traffic Management allows you to prioritize applications for optimal performance.
- **Higher productivity.** With more predictable application performance during high-traffic periods, you can use business-critical applications when and where you need them.
- **Increased flexibility.** Private Network Traffic Management lets you map your most important applications into the business-critical class of service (CoS) based on the applications' requirements.
- **New potential.** Now you can extend QoS policies traditionally provided on fixed WAN to the private network, giving you expanded network control.

Verizon Private Network Traffic Management at 2.



Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 264.

		1. PCRF sends PCC rules to P-GW with PCC Rules Provision message RAR (APN-AMBR and/or QoS rule) and P-GW acknowledges this with PCC Rules Ack message RAA (QoS Rule Report) 2a PGW uses the received QoS information to determine to update EPS default bearer with received QoS and/or APN-AMBR. 2. PGW sends **Update Bearer Request** (IMSI, Bearer Contexts (bearer level QoS is included inside this IE), GRE Key, APN-AMBR) message to SGW 3. SGW sends **Update Bearer Request** (IMSI, Bearer Contexts (bearer level QoS is included inside this IE), GRE Key, APN-AMBR) message to MME 3a UE-AMBR is updated in case APN-AMBR is modified. 3. MME builds a **Modify EPS Bearer Context Request** (Protocol Discriminator, EPS Bearer Identity, Procedure Transaction Identity, Modify EPS Bearer Context Request message Identity, TFT and/or New QoS and/or APN-AMBR) message and sends it as part of E-RAB Modify Request (Message Type, MME UE S1AP ID, eNB UE S1AP ID, E-RAB to be modified list, NAS-PDU (Modify EPS Bearer Context Request)) message to eNB. 4.-5. eNB maps modified EPS Bearer QoS to Radio Bearer QoS. It then signals **RRC Connection Reconfiguration** (Radio Resource Configuration, NAS Info (Modify EPS Bearer Context Request)) message to UE. UE stores new EPS QoS and acknowledges the radio bearer modification with **RRC Connection Reconfiguration Complete**. 6. eNB acknowledges the bearer modification to MME with a **E-RAB Modify Response** (Message Type, MME UE S1AP ID, eNB UE S1AP ID) message. With this message, eNB indicates whether the requested EPS Bearer QoS modification could be executed or not. 7. UE NAS layer builds a NAS level **Modify EPS Bearer Context Accept** (Protocol Discriminator, EPS Bearer Identity, Procedure Transaction Identity, Modify EPS Bearer Context Accept message Identity) message and sends it inside **UL Information Transfer** (Modify EPS Bearer Context Accept) message to eNB. 8. eNB sends an **Uplink NAS Transport** (Modify EPS Bearer Context Accept) message to MME. 9. Upon reception of Modify EPS Bearer Context Accept message MME acknowledges the bearer modification to S-GW by sending an **Update Bearer Response** (Cause, Bearer Contexts) message. 7. The SGW acknowledges the bearer modification to PGW by sending an **Update Bearer Response** (Cause, Bearer Contexts) message.

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 265.

15 **PCEF-Initiated IP-CAN Session Termination**
If there is no local static policy, the PCEF (PGW) sends a **CC Request (CCR) message with CC-Request-Type AVP set to TERMINATION_REQUEST**.

. . .

S1 If the PCRF had subscribed to notifications from the SPR and this is the last PDN connection for the UE then the PCRF updates the SPR to indicate IP-CAN session termination (= cancel subscription to profile updates) by sending an **Sh:SNR (subscription-request-type=unsubscribe).**

S2 The HSS responds with a confirming **SNA (Result-Code).**

16 The PCRF responds with **CC Answer (CCA)** message.

17 The PGW responds with **Delete Session Response (Cause, Recovery** (if contacting peer for the first time)).
SGW counter S5S8DeleteSessionRespAccRcvd is incremented.
The SGW forwards the message to the MME.
SGW counter S11S4DeleteSessionRespAccSent is incremented.

18. Update Location Answer
The HSS replies with **Update Location Answer (Result, ULA-Flags, Subscription Data [MSISDN, APN-Configuration list [MIP6-Agent-Info], MSISDN, PDN Type [IPv6]** (for IMS PDN))) [TS 29.272].
ULA-Flags and Subscription Data shall be present when the Result is Success. The Subscription Data includes the profile for all the subscribed APNs that the UE is allowed to connect to.

19. Create Session Request
The MME sends a **Create Session Request (IMSI, MSISDN (if available from HSS), MEI, ULI, Serving Network, RAT Type, Indication Flags, Sender F-TEID for C-plane, PGW Address for C-plane or PMIP, APN, Selection Mode, PDN Type [IPv6], PAA, Maximum APN Restriction, APN-AMBR, PCO (IPv6 DNS and P-CSCF addresses), Bearer Contexts [EBI, Bearer QoS, Charging Characteristics])** [TS 29.274]. The GTP-timer S11_T3-ResponseCreateSession specifies the maximum waiting time for a response to a Create Session Request message. S11_N3-RequestsCreateSession specifies the maximum number of attempts to send a Create Session Request message. The arithmetic product of S11_T3-ResponseCreateSession and S11_N3-RequestsCreateSession should be lesser than 30 seconds.

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 51-52.

A1 The P-GW sends **AAR {Session-ID, PGW-FQDN, IMSI-NAI , APN, [RAT-Type] }** to the 3GPP AAA to authorize the APN for the subscriber and to update P-GW address on the HSS for the APN.

A2 The 3GPP AAA updates the HSS with the P-GW address for the APN, retrieves Subscriber-APN profiles from the HSS

A3 The 3GPP AAA sends the Subscriber-APN profiles from the HSS for the UE, Adds access specific information to the Subscriber-APN profiles and returns that to the P-GW in a **AAA { Session-ID , Subscriber-APN-Profile }**. The subscriber Profile contains default APN profile and a list of authorized APN profiles. The server-name AVP in the Subscriber-APN profile carries the P-CSCF FQDN. PGW performs DNS query to resolve P-CSCF FQDN prior to returning the P-CSCF addresses in step C.3.

C.2.1 IP-CAN Session Establishment Procedure

The PCEF sends a **CC-Request** (CCR) Command with CC-Request-Type set to INITIAL_REQUEST. The following attributes shall be present: Default-EPS-Bearer-QoS, AN-GW-Address, Called-Station-Id (APN-Name), [Event-Report-Indication], 3GPP-User-Location-Info, IP-CAN Type, RAT Type, Framed-IPv6-Prefix, Subscription-Id (IMSI), [Access-network-Charging-identifier-Gx], [Offline], Network-Request-Support , [QoS-Information] User-Equipment-Info and base credit control AVP's (See 5.6.2 in TS 29.212). The subscribed APN-AMBR is included in the QoS-information AVP

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 53.

S3/4 **PCRF interaction with HSS/SPR**
The PCRF downloads (and caches) user profile (by sending an Sh:UDR (User-Identity, Service-Indication, Data-Reference) and receiving an Sh:UDA (Result-Code, User-Data)).

The PCRF may subscribe to profile update notification (by sending an Sh:SNR ((User-Identity, Service-Indication, Data-Reference)) and receiving an Sh:SNA (Result-Code).

C.2.2 On receiving a CCR the PCRF shall sends **CC-Answer** (CCA) Command to install the PCC rules and event triggers. CCA includes the following AVPs: Default-EPS-Bearer-QoS, Bearer-Control-Mode, Event-trigger (subscribe to user location change (eCGI or/and TAI (Event-Trigger=USER_LOCATION_CHANGE (13)), subscribe to serving gateway change (Event-Trigger=AN_GW_CHANGE (21)), subscribe to OUT_OF_CREDIT (15), subscribe to REALLOCATION_OF_CREDIT (16)), subscribe to IP-CAN_CHANGE (7), subscribe to RAT_CHANGE (2), subscribe to PLMN_CHANGE (4), subscribe to QOS_CHANGE (1), subscribe to DEFAULT_EPS_BEARER_QOS_CHANGE (20)]], [QoS-information], and Charging-rule-install are subject to use case. The QoS-Information AVP contains authorized APN-AMBR (APN-AMBR-UL and APN-AMBR-DL). The Charging-rule-install will include the rule required to create the dedicated bearer for SIP signaling.

Verizon and Ericsson LTE Phase 1 Call Flows, Version 1.02 PA1.0, at 53-54.

In addition to the use of 4G PCC architecture referenced above, the Verizon operator network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving a billing profile for each of said plurality of devices.

Several network functions described in the 3GPP Standards transmit and receive information elements to enforce policy decisions for services provided to UEs that access Verizon's 5G network. *See* 1[B] (detailing 5G equivalents for 3GPP network elements); *see also, e.g.*, 3GPP TS 23.503 at 14-15 (charging models and charging requirements); *id.* at 23 (PCF obtains information relating to subscriber spending from Charging Function); *id.* at 54 (PCF decisions based on policy counters maintained in Charging Function); *id.* at 61 (PCF uses information relating to subscriber spending in CHF as input for policy decisions related to QoS control, gating or charging conditions); *id.* at 63 (input for PCC decisions from CHF and UDR); *id.* at 66-69 (Policy control subscription information management).

On information and belief, the billing profile information is provided by the Verizon network management systems, including but not limited to the Verizon operations support systems (OSS) and business support systems (BSS) used

	to manage customer records, billing records, network services, and network operation. Examples of these systems are detailed below. *See* Claims 10-17 and 37-40. On information and belief, Verizon's OSS/BSS systems provide billing and charging control (including 3GPP Policy and Charging Rules Function (PCRF) and Policy Control Function (PCF)) consistent with TS23.303, which includes the establishment of IP-CAN sessions, Usage Monitoring Control (Section 4.4), an architecture that correlates to the Reference Architecture (identified in Section 5.1), QoS control (Section 4.3.3), a GX reference point (Section 5.2.2), reference points to subscriber databases (Section 5.2.3), a Policy Control and Charging Rules Function (PCRF) (Section 6.2.1.0), subscription information management in the PCRF (Section 6.2.1.2), a subscription profile repository (SPR), and a user data repository (UDR).
1[D] generating a prioritizatio n list defining an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;	Verizon's implementation of dynamic allocation of network resources includes performing the step of generating a prioritization list that is at least in part based on the billing profiles and a billing history (which identifies historical charges, usage, and payment). For example, prioritization will consider the specific plan features (which comprises part of the billing profile) and previous data usage (which comprises part of the billing history) for each of the devices at issue. *See* 1[B] and 1[C] (detailing different situations in which prioritization amongst users, devices, and plans occurs). The prioritization list defines an order for the plurality of devices accessing a shared network resource (*e.g.*, a cell tower or base station or backhaul link), based on the billing profiles and billing history for each of the plurality of devices. For example, on information and belief, Verizon generates a prioritization list to determine which, if any, device will see a decrease in data speed based on, in part, whether a user's device will experience decreased data speeds which depends on, in part, the customer's billing profile (e.g., specific plan) and billing history (e.g., the data usage for a particular billing period). Verizon prioritizes certain user's traffic over others. This prioritization is based on the billing profile (*e.g.*, data plan) and billing history (*e.g.*, high speed usage during your billing cycle or a failure to pay prior bills) associated with the device: On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans.

See, e.g., NM at 2; *see also* BSI at 3-4.

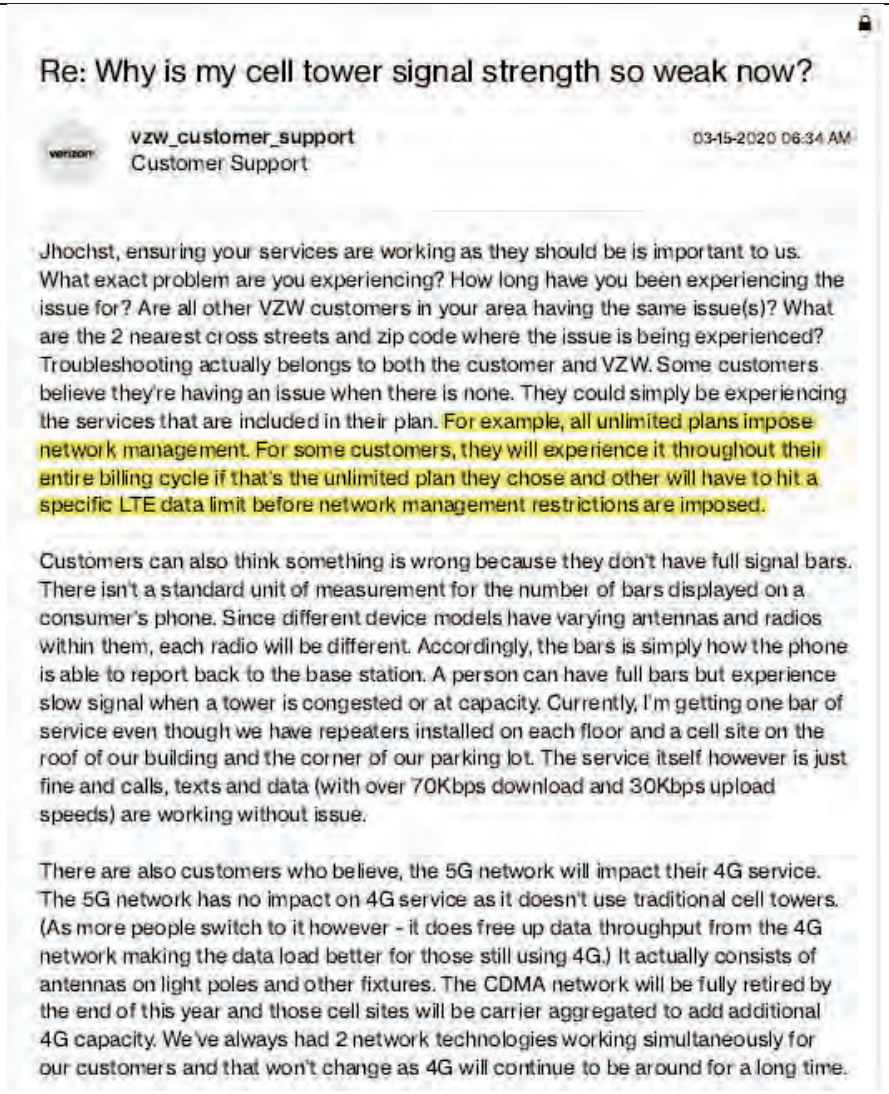
Does Verizon Wireless take any steps to manage the flow of data on the network used for Broadband Internet Access Services?

Verizon Wireless strives to provide customers the best experience when using our network, which is a shared resource among tens of millions of customers. Verizon Wireless has used sound engineering principles in the design and operation of its broadband network to ensure a good user experience for all customers. An individual user's experience will vary depending upon many factors, including the plan they select, the network (5G Ultra Wideband, 5G Nationwide, 4G LTE, or 3G Ev-DO) the customer is using, and the device in use.

See, e.g., BSI at 3.

5G Nationwide / 4G LTE: 5G Nationwide requires a 5G Nationwide compatible device. Devices manufactured before 2020 are not 5G Nationwide compatible. You will receive 4G LTE when 5G Nationwide isn't available. During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic (only after 50 GB/mo of 5G Nationwide or 4G LTE data on Play More Unlimited 5G UW, Do More Unlimited 5G UW and Get More Unlimited 5G UW). Unlimited Mobile Hotspot available on Play More, Do More and Get More Unlimited 5G UW plans. Mobile Hotspot speeds reduced to 600 Kbps (only after 15 GB/mo 5G Nationwide/4G LTE on Play More and Do More Unlimited 5G UW plans and after 30 GB/mo on the Get More Unlimited 5G UW Plan). Using Mobile Hotspot counts toward your 50 GB monthly 5G Nationwide/4G LTE plan allocation. Domestic data roaming at 2G speeds; int'l data reduced to 2G speeds after 512 MB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. 720p HD Video Streaming available on smartphones for Play More, Do More and Get More Unlimited 5G UW plans (must be turned on by customer in My Verizon online, the My Verizon App or by calling customer service); otherwise user will receive SD Video Streaming. SD (480p) Video Streaming on Start Unlimited.

See, e.g., IPI at 1.



Re: Why is my cell tower signal strength so weak now?

vzw_customer_support
Customer Support

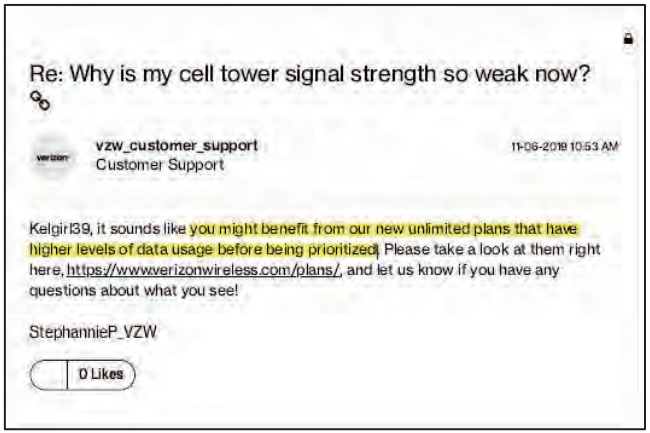
03-15-2020 06:34 AM

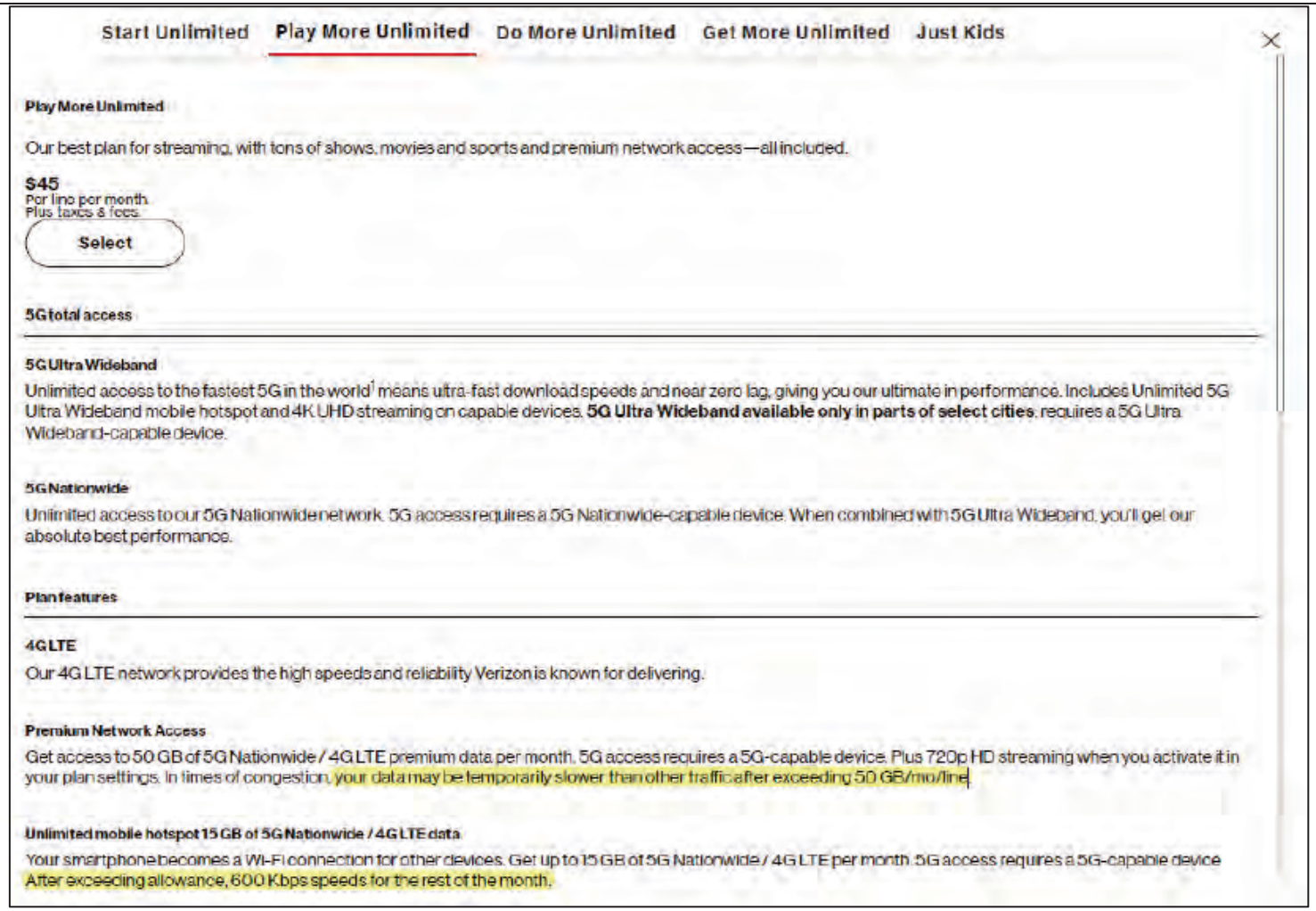
Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed.

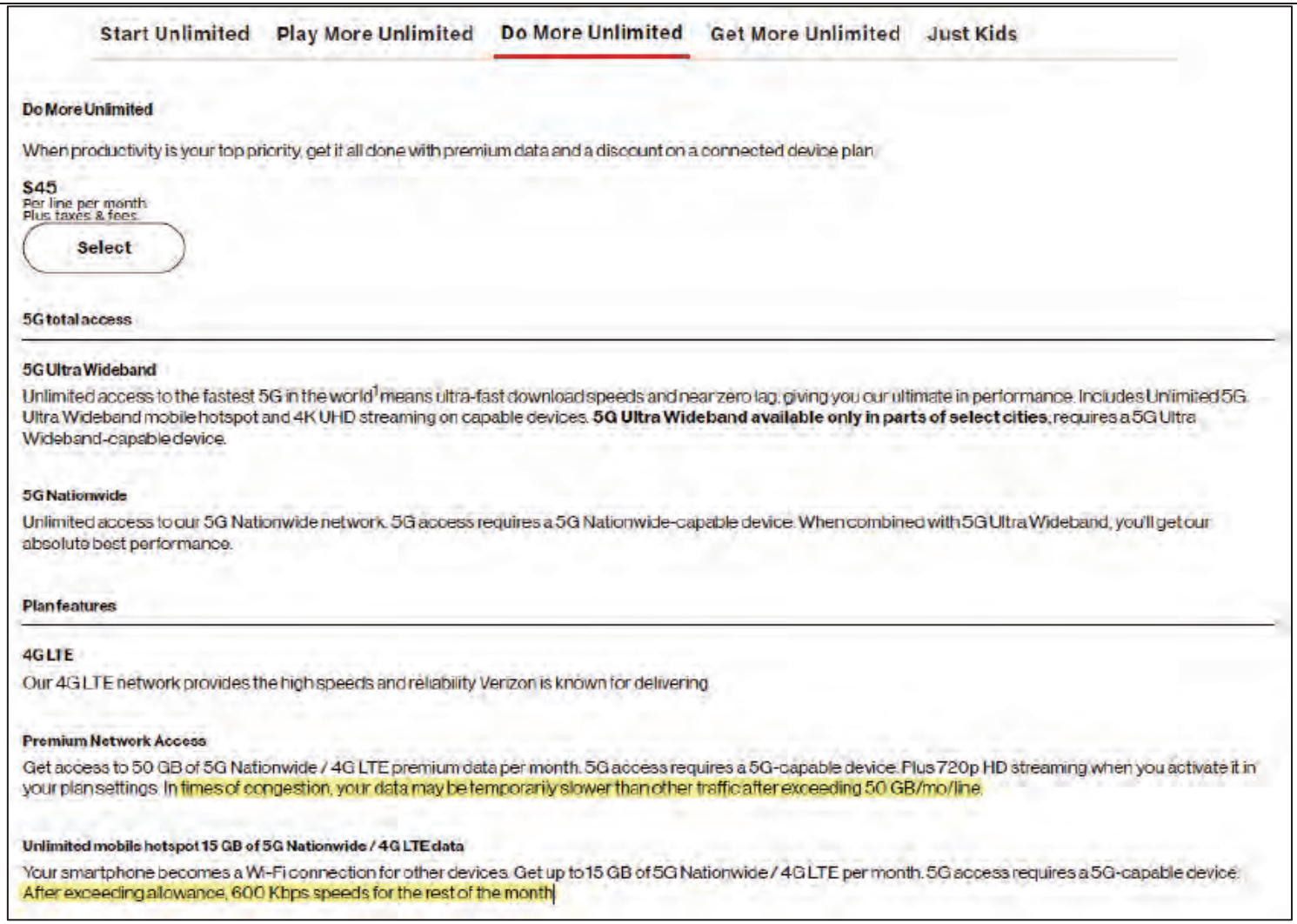
Customers can also think something is wrong because they don't have full signal bars. There isn't a standard unit of measurement for the number of bars displayed on a consumer's phone. Since different device models have varying antennas and radios within them, each radio will be different. Accordingly, the bars is simply how the phone is able to report back to the base station. A person can have full bars but experience slow signal when a tower is congested or at capacity. Currently, I'm getting one bar of service even though we have repeaters installed on each floor and a cell site on the roof of our building and the corner of our parking lot. The service itself however is just fine and calls, texts and data (with over 70Kbps download and 30Kbps upload speeds) are working without issue.

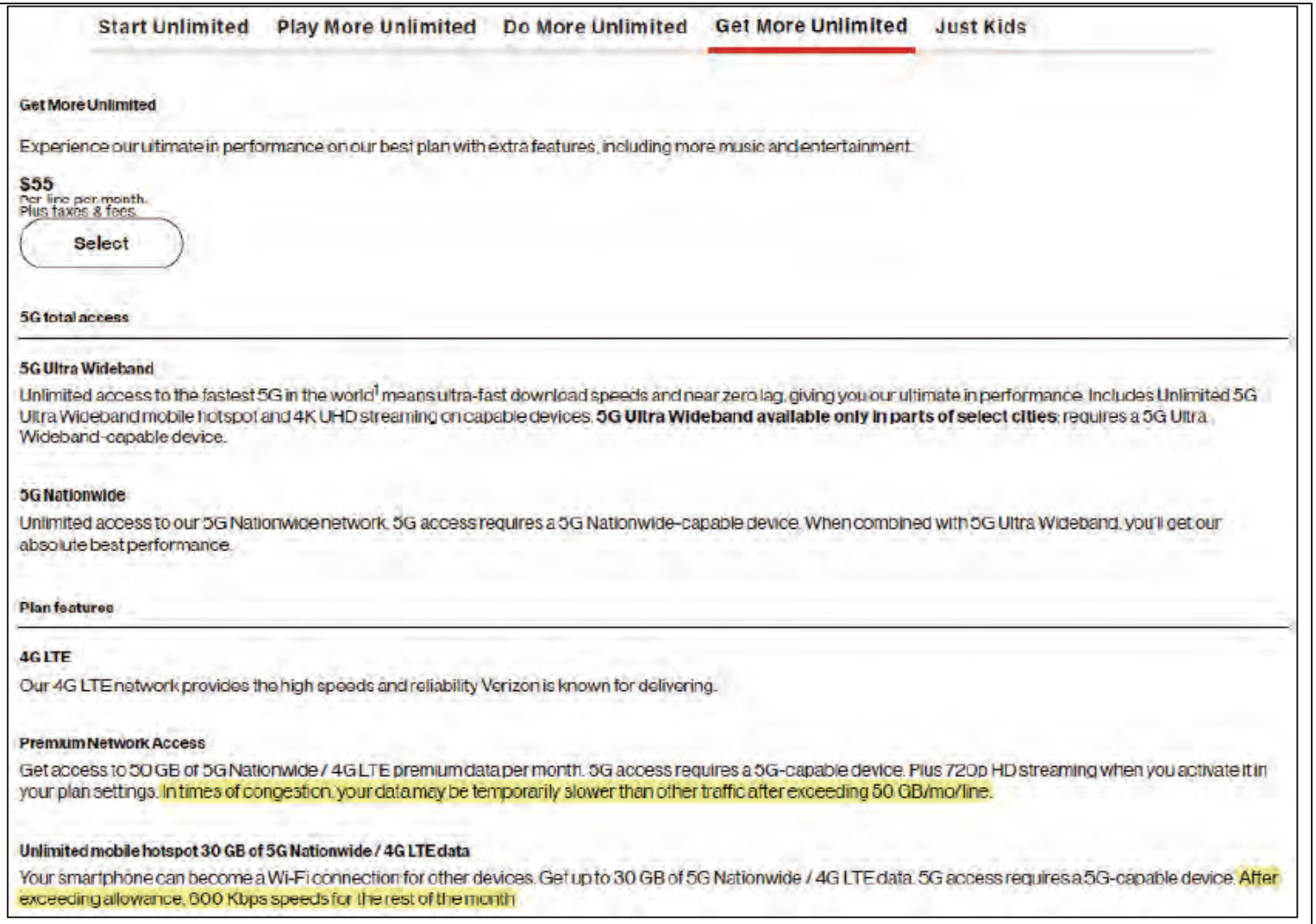
There are also customers who believe, the 5G network will impact their 4G service. The 5G network has no impact on 4G service as it doesn't use traditional cell towers. (As more people switch to it however - it does free up data throughput from the 4G network making the data load better for those still using 4G.) It actually consists of antennas on light poles and other fixtures. The CDMA network will be fully retired by the end of this year and those cell sites will be carrier aggregated to add additional 4G capacity. We've always had 2 network technologies working simultaneously for our customers and that won't change as 4G will continue to be around for a long time.

See https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).

	Verizon explains the impact of being deprioritized for exceeding data volume caps during a billing cycle for plans that are not fully unlimited:  *See* *https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/9* (last visited Dec. 9, 2021).


Start Unlimited
Play More Unlimited
Do More Unlimited
Get More Unlimited
Just Kids
Play More Unlimited
Our best plan for streaming, with tons of shows, movies and sports and premium network access—all included.
$45
Per line per month
Plus taxes & fees
Select
5G total access
5G Ultra Wideband
Unlimited access to the fastest 5G in the world[1] means ultra-fast download speeds and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities, requires a 5G Ultra Wideband-capable device.
5G Nationwide
Unlimited access to our 5G Nationwide network. 5G access requires a 5G Nationwide-capable device. When combined with 5G Ultra Wideband, you'll get our absolute best performance.
Plan features
4G LTE
Our 4G LTE network provides the high speeds and reliability Verizon is known for delivering.
Premium Network Access
Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. 5G access requires a 5G-capable device. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your data may be temporarily slower than other traffic after exceeding 50 GB/mo/line.
Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data
Your smartphone becomes a Wi-Fi connection for other devices. Get up to 15 GB of 5G Nationwide / 4G LTE per month. 5G access requires a 5G-capable device. After exceeding allowance, 600 Kbps speeds for the rest of the month.


Start Unlimited
Play More Unlimited
Do More Unlimited
Get More Unlimited
Just Kids
Do More Unlimited
When productivity is your top priority, get it all done with premium data and a discount on a connected device plan.
$45
Per line per month
Plus taxes & fees
Select
5G total access
5G Ultra Wideband
Unlimited access to the fastest 5G in the world[1] means ultra-fast download speeds and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities, requires a 5G Ultra Wideband-capable device.
5G Nationwide
Unlimited access to our 5G Nationwide network. 5G access requires a 5G Nationwide-capable device. When combined with 5G Ultra Wideband, you'll get our absolute best performance.
Plan features
4G LTE
Our 4G LTE network provides the high speeds and reliability Verizon is known for delivering.
Premium Network Access
Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. 5G access requires a 5G-capable device. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your data may be temporarily slower than other traffic after exceeding 50 GB/mo/line.
Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data
Your smartphone becomes a Wi-Fi connection for other devices. Get up to 15 GB of 5G Nationwide / 4G LTE per month. 5G access requires a 5G-capable device. After exceeding allowance, 600 Kbps speeds for the rest of the month.



https://www.verizon.com/plans/unlimited/ (last visited Dec. 3, 2021).

The 3GPP Standards describe the use of 4G PCC architecture to prioritize services to certain UEs based on billing profiles and billing history information. For example, the PCRF can receive information from various sources as inputs to build PCC rules that affect the provision of services to UEs.

> 6.1.6 Service (data flow) Prioritization and Conflict Handling
>
> Service pre-emption priority enables the PCRF to resolve conflicts where the activation of all requested active PCC rules for services would result in a cumulative authorized QoS which exceeds the Subscribed Guaranteed bandwidth QoS.
>
> For example, when supporting network controlled QoS, the PCRF may use the pre-emption priority of a service, the activation of which would cause the subscriber's authorized QoS to be exceeded. If this pre-emption priority is greater than that of any one or more active PCC rules, the PCRF can determine whether the deactivation of any one or more such rules would allow the higher pre-emption priority PCC rule to be activated whilst ensuring the resulting cumulative QoS does not exceed a subscriber's Subscribed Guaranteed Bandwidth QoS.
>
> If such a determination can be made, the PCRF may resolve the conflict by deactivating those selected PCC rules with lower pre-emption priorities and accepting the higher priority service information from the AF. If such a determination cannot be made, the PCRF may reject the service information from the AF.

3GPP TS 23.203 at 48.

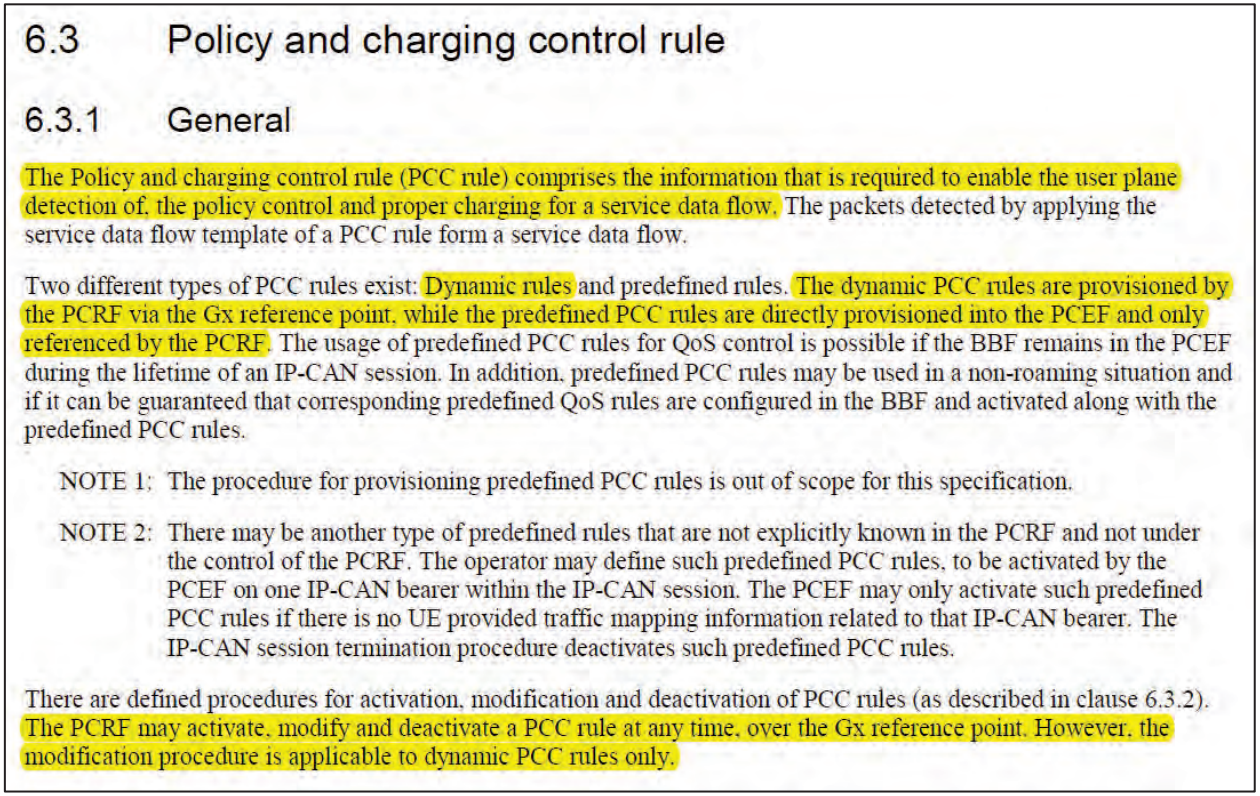
> 6.2.1.1 Input for PCC decisions
>
> The PCRF shall accept input for PCC decision-making from the PCEF, the BBERF if present, the TDF if present, the SPR and if the AF is involved, from the AF, as well as the PCRF may use its own predefined information. These different nodes should provide as much information as possible to the PCRF. At the same time, the information below describes examples of the information provided. Depending on the particular scenario all the information may not be available or is already provided to the PCRF.

3GPP TS 23.203 at 76.

	The SPR may provide the following information for a subscriber, connecting to a specific PDN:
	- Subscriber's allowed services, i.e. list of Service IDs;
	- For each allowed service, a pre-emption priority;
	- Information on subscriber's allowed QoS, including:
	  - the Subscribed Guaranteed Bandwidth QoS;
	  - a list of QoS class identifiers together with the MBR limit and, for real-time QoS class identifiers, GBR limit.
	- Subscriber's charging related information;
	- Spending limits profile containing an indication that policy decisions depend on policy counters available at the OCS that has a spending limit associated with it and optionally the list of relevant policy counters.
	- Subscriber category;
	- Subscriber's usage monitoring related information;
	- Subscriber's profile configuration;
	- Sponsored data connectivity profiles;
	- MPS EPS Priority, MPS Priority Level (See TS 23.401 [17] for more detail on MPS Subscription);
	- IMS Signalling Priority.
	
	3GPP TS 23.203 at 77.

	6.2.2.4 QoS control The PCEF enforces the authorized QoS for an IP-CAN bearer according to the information received via the Gx interface and depending on the bearer establishment mode. Only the GBR per bearer is used for resource reservation (e.g. admission control in the RAN). The MBR (per PCC rule / per bearer) is used for rate policing. For a UE-initiated IP-CAN bearer establishment or modification the PCEF receives the authorized QoS (QCI, ARP, GBR, MBR) for a bearer that the PCEF has identified for the PCRF. The PCEF shall enforce it which may lead to a downgrading or upgrading of the requested bearer QoS. NOTE 1: The MBR is an average value, which is measured over some time period. Services may generate media with variable bitrate. For example, TS 26.114 [45] describes the bitrate variations that may be generated for real-time conversational media in the MTSI service. The policing function in the PCEF should take such bitrate variations into account. For a network initiated IP-CAN bearer establishment or modification the PCEF receives the authorized QoS per PCC rule (QCI, ARP, GBR, MBR). For GBR bearers the PCEF should set the bearer's GBR to the sum of the GBRs of all PCC rules that are active and bound to that GBR bearer. If a set of PCC Rules is subject to resource sharing as specified in clause 6.1.14 the PCEF should use, for each applicable direction, the highest GBR from the set of PCC Rules sharing resources as input for calculating the bearer´s GBR. For GBR bearers the PCEF should set the bearer's MBR to the sum of the MBRs of all PCC rules that are active and bound to that GBR bearer. If a set of PCC Rules is subject to resource sharing as specified in clause 6.1.14 the PCEF may, for each applicable direction, use the highest MBR from the set of PCC Rules as input for calculating the bearer´s MBR. 3GPP TS 23.203 at 91-92.

The PCRF uses PCC rules to implement its policies and prioritizations.



6.3 Policy and charging control rule

6.3.1 General

The Policy and charging control rule (PCC rule) comprises the information that is required to enable the user plane detection of, the policy control and proper charging for a service data flow. The packets detected by applying the service data flow template of a PCC rule form a service data flow.

Two different types of PCC rules exist: Dynamic rules and predefined rules. The dynamic PCC rules are provisioned by the PCRF via the Gx reference point, while the predefined PCC rules are directly provisioned into the PCEF and only referenced by the PCRF. The usage of predefined PCC rules for QoS control is possible if the BBF remains in the PCEF during the lifetime of an IP-CAN session. In addition, predefined PCC rules may be used in a non-roaming situation and if it can be guaranteed that corresponding predefined QoS rules are configured in the BBF and activated along with the predefined PCC rules.

NOTE 1: The procedure for provisioning predefined PCC rules is out of scope for this specification.

NOTE 2: There may be another type of predefined rules that are not explicitly known in the PCRF and not under the control of the PCRF. The operator may define such predefined PCC rules, to be activated by the PCEF on one IP-CAN bearer within the IP-CAN session. The PCEF may only activate such predefined PCC rules if there is no UE provided traffic mapping information related to that IP-CAN bearer. The IP-CAN session termination procedure deactivates such predefined PCC rules.

There are defined procedures for activation, modification and deactivation of PCC rules (as described in clause 6.3.2). The PCRF may activate, modify and deactivate a PCC rule at any time, over the Gx reference point. However, the modification procedure is applicable to dynamic PCC rules only.

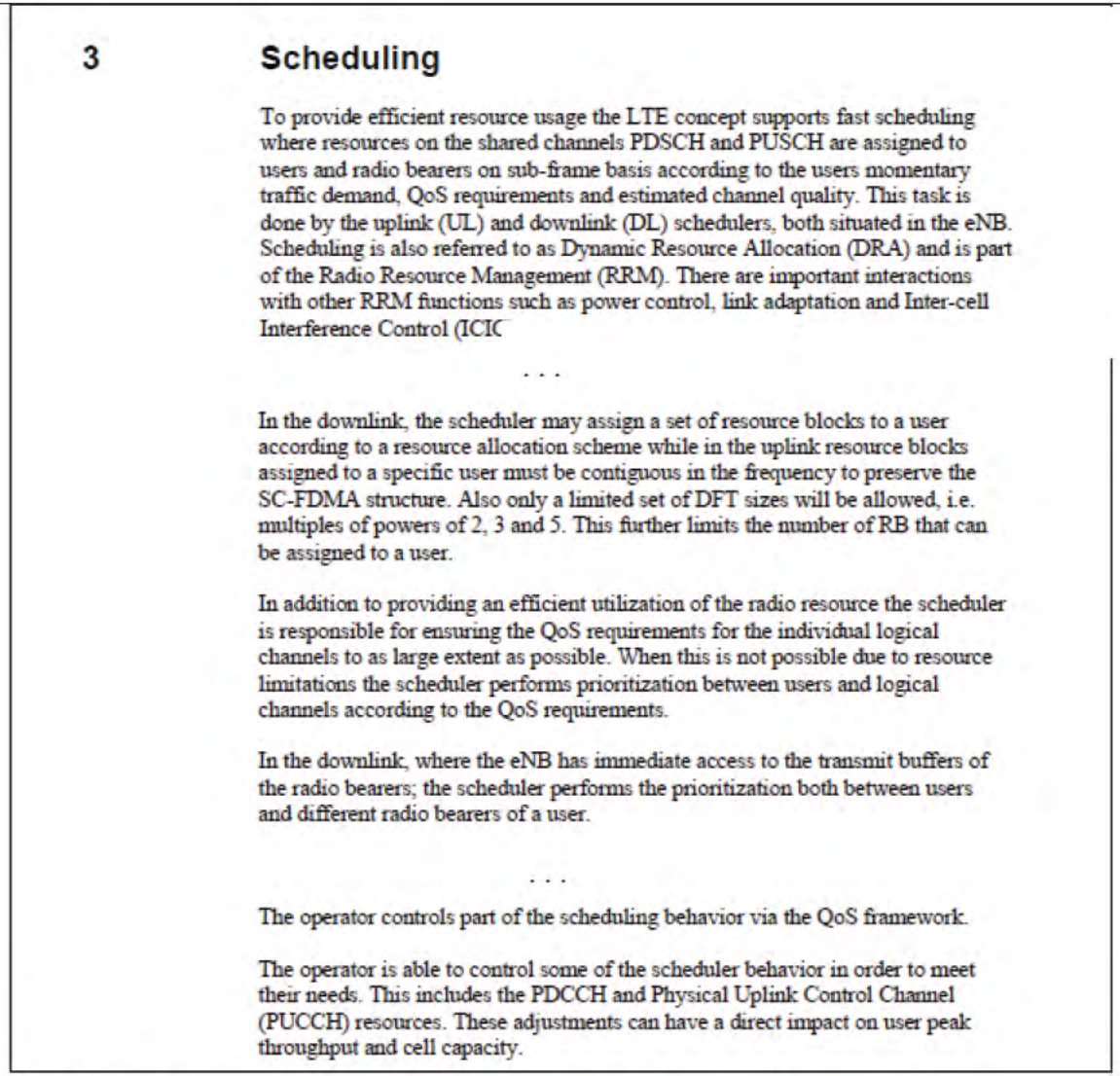
3GPP TS 23.203 at 99; *see also id.* at 100-104 (detailing the PCC rule information).

These PCC rules include Allocation and Retention Priority (ARP) characteristics that can be used to prioritize sessions.

	6.1.7.3 Allocation and Retention Priority characteristics The QoS parameter ARP contains information about the priority level, the pre-emption capability and the pre-emption vulnerability. The priority level defines the relative importance of a resource request. This allows deciding whether a bearer establishment or modification request can be accepted or needs to be rejected in case of resource limitations (typically used for admission control of GBR traffic). It can also be used to decide which existing bearers to pre-empt during resource limitations. NOTE 1: The ARP priority level can be used in addition to the QCI to determine the transport level packet marking, e.g. to set the DiffServ Code Point of the associated EPS bearer, as described in TS 23.401 [17]. NOTE 2: When required by operator policy, the eNodeB can be configured to use the ARP priority level in addition to QCI priority level to control the packet forwarding treatment for SDFs having high priority ARPs. The range of the ARP priority level is 1 to 15 with 1 as the highest level of priority. The pre-emption capability information defines whether a service data flow can get resources that were already assigned to another service data flow with a lower priority level. The pre-emption vulnerability information defines whether a service data flow can lose the resources assigned to it in order to admit a service data flow with higher priority level. The pre-emption capability and the pre-emption vulnerability can be either set to 'yes' or 'no'. The ARP priority levels 1-8 should only be assigned to resources for services that are authorized to receive prioritized treatment within an operator domain (i.e. that are authorized by the serving network). The ARP priority levels 9-15 may be assigned to resources that are authorized by the home network and thus applicable when a UE is roaming. NOTE 3: This ensures that future releases may use ARP priority level 1-8 to indicate e.g. emergency and other priority services within an operator domain in a backward compatible manner. This does not prevent the use of ARP priority level 1-8 in roaming situation in case appropriate roaming agreements exist that ensure a compatible use of these priority levels. 3GPP TS 23.203 at 56.

	Publicly available documentation reveals that Verizon uses PCC functionality described in the 3GPP Standards to prioritize services for certain UEs over others. As a result, on information and belief, prioritization lists are generated based on billing profiles and on a billing history when a PCRF/PCF interfaces with other network elements, such as gateway components (e.g., P-GW, S-GW, SGW-PGW), radio access networks (e.g., E-UTRAN, NG-RAN), and base stations (e.g., eNodeB, gNodeB). 8. Describe what happens when all public network traffic has been preempted and the network becomes overloaded with public safety traffic. Verizon's Response The Radio Access Network (RAN) consists of access and radio resource connections. The RAN is regularly overloaded during special events resulting in access and radio connection failures – stadium events, parades, New Year's Eve celebrations, and disaster events such as 9/11, the Boston Marathon Bombing, Hurricane Katrina, Super Storm Sandy, earthquakes, tornados, etc. The RAN can also overload in particularly high network traffic areas on a daily basis. WPS enables authorized users to gain priority access to the next available wireless channel, thereby increasing their probability of call completion during an emergency. Verizon Wireless has all three configured in the access network. ACB and HPA have been deployed since June 8th 2017. ARP with preemption was recently deployed in the public safety market. ACB: Provides priority at the cell site access that is essentially the knock at the door "Let me in". The cell site (eNodeB) knows when it is in overload and cannot process further requests (knocks on the door). Upon that situation, the cell site begins a probabilistic barring process of non-priority users. When congestion clears, barring is removed. During barring, priority users are exempt from barring and essentially get to the head of the line. HPA: Priority user requests are marked as "HPA." The cell site then assigns a radio resource even when non-priority users are blocking at radio resources. ARP: This provides for preemption. Due to the efficacy of ACB and HPA there have been no instances of network conditions which would result in pre-emption being necessary. VZW recently launched preemption and it is a valuable tool in the priority tool box that is available nationwide. Verizon Network Technology Questionnaire, at 53.

	As one example, Ericsson documentation discloses the use of prioritization and preemption using PCC architecture and QoS parameters. In order to restrict the number of simultaneous access attempts, it is also possible to restrict access for certain access classes and access types using **acBarringInfo**. Access class barring offers a possibility to deny access for a certain fraction of UE to save network resources, for example, in situations where network resources have the risk to become congested. Access class barring allows normal service to be maintained for UE of special access classes and for the fraction of UE where access is granted. Ericsson LTE L13 Radio Network Functionality Student Book, LZT1380914 R1A, at 25. **4.9.2 Access Class Restriction Information** The right to perform certain types of access in the cell is controlled by the *acBarringInfo* broadcast in system information (SIB type 2). It applies to mobile originating access. The *acBarringInfo* information distinguishes mobile originating access for the purpose of initiating the following: • An emergency call (not supported in Rel-8, but the barring information is included in sys info, as a preparation for Rel-9) • A connection for signaling purposes • A connection for user data transfer Ericsson LTE L13 Radio Network Functionality Student Book, LZT1380914 R1A, at 55.



3 Scheduling

To provide efficient resource usage the LTE concept supports fast scheduling where resources on the shared channels PDSCH and PUSCH are assigned to users and radio bearers on sub-frame basis according to the users momentary traffic demand, QoS requirements and estimated channel quality. This task is done by the uplink (UL) and downlink (DL) schedulers, both situated in the eNB. Scheduling is also referred to as Dynamic Resource Allocation (DRA) and is part of the Radio Resource Management (RRM). There are important interactions with other RRM functions such as power control, link adaptation and Inter-cell Interference Control (ICIC

. . .

In the downlink, the scheduler may assign a set of resource blocks to a user according to a resource allocation scheme while in the uplink resource blocks assigned to a specific user must be contiguous in the frequency to preserve the SC-FDMA structure. Also only a limited set of DFT sizes will be allowed, i.e. multiples of powers of 2, 3 and 5. This further limits the number of RB that can be assigned to a user.

In addition to providing an efficient utilization of the radio resource the scheduler is responsible for ensuring the QoS requirements for the individual logical channels to as large extent as possible. When this is not possible due to resource limitations the scheduler performs prioritization between users and logical channels according to the QoS requirements.

In the downlink, where the eNB has immediate access to the transmit buffers of the radio bearers; the scheduler performs the prioritization both between users and different radio bearers of a user.

. . .

The operator controls part of the scheduling behavior via the QoS framework.

The operator is able to control some of the scheduler behavior in order to meet their needs. This includes the PDCCH and Physical Uplink Control Channel (PUCCH) resources. These adjustments can have a direct impact on user peak throughput and cell capacity.

Ericsson LTE L13 Radio Network Functionality Student Book, LZT1380914 R1A, at 86.

	See also Ericsson LTE L13 Radio Network Functionality Student Book, LZT1380914 R1A, at 205-07 (differentiated admission control). In addition to the use of 4G PCC architecture referenced above, the Verizon network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, which describe the prioritization of services to certain UEs based on billing profiles and billing history information. For example, the PCF can receive information from various sources as inputs to build PCC rules that affect the provision of services to UEs. *See, e.g.*, 3GPP TS 23.503 at 48 (service prioritization and conflict handling); *id.* at 63-66 (input for PCC decisions); *id.* at 6.2.2.4 (QoS control); *id.* at 76-84 (detailing PCC rules). On information and belief, the prioritization list is generated by the Verizon network management systems, including but not limited to the Verizon operations support systems (OSS) and business support systems (BSS) used to manage customer records, billing records, network services, and network operation. Examples of these systems are detailed below. *See* Claims 10-17 and 37-40.
1[E] repeating:	Verizon's implementation of dynamic allocation of network resources includes repeating steps 1[F], 1[G], 1[H], and 1[I] below. As noted above, Verizon repeats its network management process as available network capacity changes and as devices move into and out of a cell site: On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4.
1[F] receiving traffic profiles over said network resource for	Verizon's implementation of dynamic allocation of network resources includes performing the step of receiving traffic profiles (*e.g.*, data volumes, data rates, and/or content being carried over the network resource from devices sharing the resource) over Verizon's network. For example, the network management system considers the traffic load of the network resource for the plurality of devices running over that network resource to determine if the network experiences "congestion" or "begins experiencing high demand":

said plurality of devices;	On certain plans, we may prioritize your 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. NM at 2, 4; BSI at 4. 5G Nationwide / 4G LTE: 5G Nationwide requires a 5G Nationwide compatible device. Devices manufactured before 2020 are not 5G Nationwide compatible. You will receive 4G LTE when 5G Nationwide isn't available. During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic (only after 50 GB/mo of 5G Nationwide or 4G LTE data on Play More Unlimited 5G UW, Do More Unlimited 5G UW and Get More Unlimited 5G UW). Unlimited Mobile Hotspot available on Play More, Do More and Get More Unlimited 5G UW plans. Mobile Hotspot speeds reduced to 600 Kbps (only after 15 GB/mo 5G Nationwide/4G LTE on Play More and Do More Unlimited 5G UW plans and after 30 GB/mo on the Get More Unlimited 5G UW Plan). Using Mobile Hotspot counts toward your 50 GB monthly 5G Nationwide/4G LTE plan allocation. Domestic data roaming at 2G speeds; int'l data reduced to 2G speeds after 512 MB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. 720p HD Video Streaming available on smartphones for Play More, Do More and Get More Unlimited 5G UW plans (must be turned on by customer in My Verizon online, the My Verizon App or by calling customer service); otherwise user will receive SD Video Streaming. SD (480p) Video Streaming on Start Unlimited. **JustKids** During times of congestion, your data may be temporarily slower than other traffic. Speeds up to 5 Mbps. SD (480p) Video Streaming. One line on account must be on an Unlimited Plan and designated a Parent Line. Smart Family app must be active on Parent's line to control the list of trusted contacts. Access to certain third-party messaging and calling applications must be controlled by Parent on *See, e.g.*, IPI at 1.

> You must be using an approved, network compatible device and be within the Verizon coverage area to access the Verizon network. Whether you experience these speeds depends on many factors, including among others, the type of device, the programs running on the device, your location, and how many other customers are attempting to use the same spectrum resources (including both mobile broadband internet access and other non-broadband internet access services that share the network, such as Private Network Traffic Management, HD Voice, Push to Talk Plus, and MDM). For information on our network and testing of the network, go to https://www.verizon.com/featured/our-network/ (/featured/our-network/)

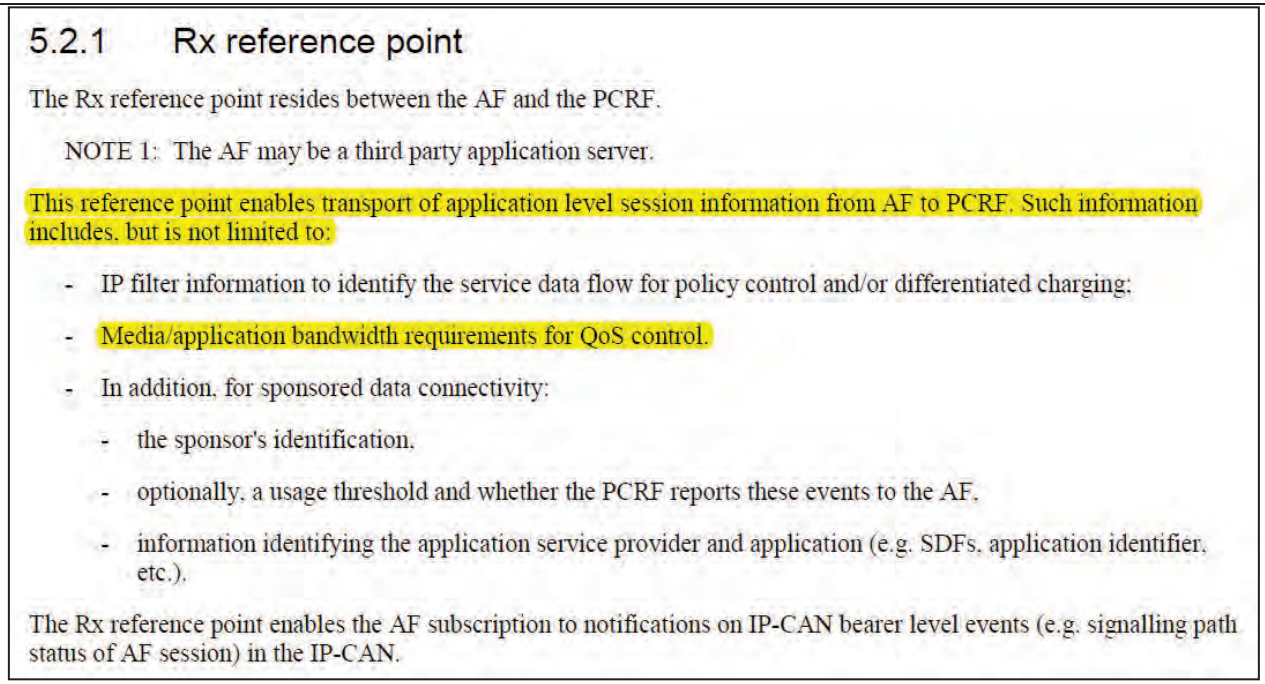
See, e.g., BSI at 3.

The 3GPP Standards describe the use of the PCC architecture in Verizon's operator network and other network elements to transmit and receive traffic-related information.

> The PCC architecture shall support topology hiding.
>
> It should be possible to use PCC architecture for handling IMS-based emergency service and Restricted Local Operator Services.
>
> It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control.
>
> It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling.
>
> The PCC architecture shall support making policy decisions based on subscriber spending limits.
>
> The PCC architecture shall support making policy decisions based on RAN user plane congestion status.
>
> The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43].
>
> The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering.

3GPP TS 23.203 at 21.

For instance, the Rx reference point provides session level information to the PCRF.



5.2.1 Rx reference point

The Rx reference point resides between the AF and the PCRF.

NOTE 1: The AF may be a third party application server.

This reference point enables transport of application level session information from AF to PCRF. Such information includes, but is not limited to:

- IP filter information to identify the service data flow for policy control and/or differentiated charging;
- Media/application bandwidth requirements for QoS control.
- In addition, for sponsored data connectivity:
  - the sponsor's identification.
  - optionally, a usage threshold and whether the PCRF reports these events to the AF.
  - information identifying the application service provider and application (e.g. SDFs, application identifier, etc.).

The Rx reference point enables the AF subscription to notifications on IP-CAN bearer level events (e.g. signalling path status of AF session) in the IP-CAN.

3GPP TS 23.203 at 31.

As another example, the AF provides traffic profile information to the PCRF.

For policy control, the AF interacts with the PCRF and the PCRF interacts with the PCEF as instructed by the AF. For certain events related to policy control, the AF shall be able to give instructions to the PCRF to act on its own, i.e. based on the service information currently available. The following events are subject to instructions from the AF:

- The authorization of the service based on incomplete service information;

NOTE 1: The QoS authorization based on incomplete service information is required for e.g. IMS session setup scenarios with available resources on originating side and a need for resource reservation on terminating side.

- The immediate authorization of the service;
- The gate control (i.e. whether there is a common gate handling per AF session or an individual gate handling per AF session component required);
- The forwarding of IP-CAN bearer level information or events:
  - Type of IP-CAN (e.g. GPRS, etc.);
  - Transmission resource status (established/released/lost);
  - Access Network Charging Correlation Information;
  - Credit denied.

NOTE 2: The credit denied information is only relevant for AFs not performing service charging.

To enable the binding functionality, the UE and the AF shall provide all available flow description information (e.g. source and destination IP address and port numbers and the protocol information). The UE shall use the traffic mapping information to indicate downlink and uplink IP flows.

3GPP TS 23.203 at 48.

	The AF, if involved, may provide the following application session related information, e.g. based on SIP and SDP: - Subscriber Identifier; - IP address of the UE; - Media Type; - Media Format, e.g. media format sub-field of the media announcement and all other parameter information (a= lines) associated with the media format; - Bandwidth; - Sponsored data connectivity information (see clause 5.2.1); - Flow description, e.g. source and destination IP address and port numbers and the protocol; 3GPP TS 23.203 at 77-78. The PCEF also provides usage monitoring to the PCRF. The PCEF shall support usage monitoring as specified in clause 4.4. The PCEF enhanced with ADC shall handle application traffic detection as per request from PCRF as well as report about the detected application traffic along with service data flow descriptions, if deducible, to the PCRF, if requested by the PCRF. 3GPP TS 23.203 at 86.

Event triggers also provide traffic profile information to the PCRF.

6.1.4 Event Triggers

The Event Reporting Function (ERF) performs event trigger detection. When an event matching the event trigger occurs, the ERF shall report the occurred event to the PCRF. The Event Reporting Function is located either at the PCEF or, at the BBERF (if applicable) or, at the TDF for solicited application reporting (if applicable).

The event triggers define the conditions when the ERF shall interact again with PCRF after an IP-CAN session establishment. The event triggers that are required in procedures shall be unconditionally reported from the ERF, while the PCRF may subscribe to the remaining events. Whether an event trigger requires a subscription by the PCRF is indicated in column 4 in table 6.2 below.

The PCRF subscribes to new event triggers or remove armed event triggers unsolicited at any time or upon receiving a request from the AF, an event report or rule request from the ERF (PCEF or BBERF or TDF) using the Provision of PCC Rules procedure or the Provision of QoS Rules procedure (if applicable) or the Provision of ADC Rules procedure (if applicable). If the provided event triggers are associated with certain parameter values then the ERF shall include those values in the response back to the PCRF. Event triggers are associated with all rules at the ERF of an IP-CAN session (ERF is located at PCEF) or Gateway Control session (ERF is located at BBERF) or with Traffic Detection session (ERF is located in TDF). Event triggers determine when the ERF shall signal to the PCRF that an IP-CAN bearer has been modified. It shall be possible for the ERF to react on the event triggers listed in table 6.2.

3GPP TS 23.203 at 42. For instance, the following event triggers are available:

Usage report (see note 7)	The IP-CAN session or the Monitoring key specific resources consumed by a UE either reached the threshold or needs to be reported for other reasons.	PCEF, TDF	PCRF
Start of application traffic detection and Stop of application traffic detection (see note 8)	The start or the stop of application traffic has been detected.	PCEF, TDF	PCRF

3GPP TS 23.203 at 44.

Additionally, the Traffic Detection Function provides traffic profile information.

> 6.2.9 Traffic Detection Function (TDF)
>
> 6.2.9.1 General
>
> The TDF is a functional entity that performs application detection and reporting of detected application and its service data flow description to the PCRF. The TDF supports solicited application reporting and/or unsolicited application reporting. The application detection filter may be extended with the PFDs provided by the PFDF as described in clause 6.1.20. The new PFDs provided by the PFDF replace the existing ones in the PCEF.

3GPP TS 23.203 at 96.

Further, the Np reference point provides congestion information to the PCRF.

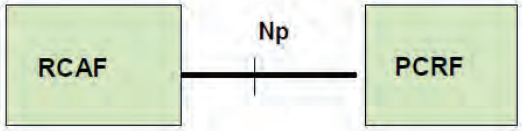
> 5.2.12 Np reference point
>
> The Np reference point resides between the RCAF and the PCRF.
>
> The Np reference point enables transport of RAN User Plane Congestion Information (RUCI) sent from the RCAF to the PCRF for all or selected subscribers, depending on the operator's congestion mitigation policy.
>
> The Np reference point supports the following functions:
>
> - Reporting of RUCI from the RCAF to the PCRF.
> - Sending, updating and removal of the reporting restrictions from the PCRF to the RCAF as defined in clause 6.1.15.2.

3GPP TS 23.203 at 34.

The RCAF provides congestion-related information, including traffic profile information, to the PCRF so it can account for that information in making its policy decisions.

> 4.3.1 RCAF
>
> The RCAF is a functional element which reports RAN User Plane Congestion Information (RUCI) via the Np interface to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions. RUCI includes the following information:
>
> - The user id (e.g. IMSI) identifying the UE impacted by congestion;
> - PDN ID for which congestion information is reported;
> - Congestion level information (either congestion level value or congestion level set id) of the UE impacted by congestion;
> - eNodeB identifier, ECGI or SAI identifying the eNodeB, E-UTRAN cell or Service Area respectively, serving the UE if a conditional restriction to restrict location reporting is not enabled.
>
> NOTE 1: In case of E-UTRAN, whether the eNodeB identifier or the ECGI are included in the RUCI is up to operator configuration in the RCAF.

3GPP TS 29.217 version 16.0.0 Release 16, at 8 (2020-08).

> 4.2 Np reference model
>
> The relationships between the involved functional entities are depicted in figure 4.2.1. The overall PCC architecture is depicted in clause 3a of 3GPP TS 29.213 [3] .
>
> 
>
>
> **Figure 4.2.1: Np reference model**

3GPP TS 29.217 version 16.0.0 Release 16, at 8 (2020-08).

> 4.3.2 PCRF
>
> The PCRF is a functional element that encompasses policy control decision and flow based charging control functionalities.
>
> The PCRF may receive RUCI from the RCAF as input for policy decisions of congestion mitigation. The PCRF may provide, update or remove the reporting restrictions of RUCI, or stop or enable RUCI reporting for a given user id and PDN ID. The PCRF may enable or disable the reporting of congestion location identifier as part of RUCI. The PCRF may also remove the context at the RCAF for a given user id and PDN ID.

3GPP TS 29.217 version 16.0.0 Release 16, at 9 (2020-08).

> **RAN user plane congestion:** RAN user plane congestion occurs when the demand for RAN resources exceeds the available RAN capacity to deliver the user data for a prolonged period of time.

3GPP TS 23.203 at 18. "The PCRF can receive RAN User Plane Congestion Information from the RAN Congestion Awareness Function (RCAF)." *Id.* at 28.

The congestion information is provided over the Np reference point.

> 4.4 Procedures over Np reference point
>
> 4.4.1 RUCI Report
>
> 4.4.1.1 General
>
> The RCAF shall perform the RUCI reporting to the PCRF when at least one of the following conditions applies:
>
> - the RCAF detects a UE in the congestion area for the first time;
> - a reporting restriction is enabled and the congestion level set id is changed;

3GPP TS 29.217 version 16.0.0 Release 16, at 9 (2020-08).

6.1.15 Reporting of RAN user plane congestion information

6.1.15.1 General

RAN User Plane Congestion Information (RUCI) is reported to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

The RUCI includes the following information:

- The IMSI identifying the UE impacted by congestion;
- eNB identifier, ECGI or SAI identifying the eNB, E-UTRAN cell or Service Area, respectively, serving the UE.

NOTE: Whether in case of E-UTRAN the eNB identifier or the ECGI is included in the RUCI is up to operator configuration in the RCAF.

- APN for which congestion information is reported;
- Congestion level or an indication of the "no congestion" state.

6.1.15.2 Reporting restrictions

Depending on the operator's congestion mitigation policy, it may not be necessary to have RUCI reporting for all users. An operator shall be able to specify restrictions for RUCI reporting on a per UE per APN basis. Reporting restrictions can be used to activate or deactivate the RUCI reporting. Reporting restrictions can also be used to limit RUCI reporting. This is achieved by defining one or more sets of congestion levels, such that the RCAF indicates only that the UE experiences a congestion level within the given set but does not indicate the congestion level itself within that set.

3GPP TS 23.203 at 62.

6.1.15.3 UE mobility between RCAFs

A RCAF is assumed to serve a geographical area. A UE may move from the area handled by one RCAF to an area handled by a different RCAF. RCAF nodes cannot detect mobility by themselves: an RCAF node cannot differentiate whether a UE that is no longer affected by congestion has moved to another RCAF or not. When a given RCAF indicates no congestion to the PCRF for a given UE on the Np interface, this should be interpreted as no congestion experienced at the given RCAF which does not exclude that another RCAF may report that the same UE experiences congestion.

Consistent operation for UE mobility is ensured by applying the following rules at the PCRF.

- The PCRF maintains the RCAF which has last indicated that the UE is affected by congestion.
- When a new RCAF indicates that the UE is affected by congestion, the PCRF sends a message to the old RCAF to explicitly release context at the old RCAF.

3GPP TS 23.203 at 63.

4.4.12 RAN Congestion Awareness Function

The RAN Congestion Awareness Function (RCAF) is an element that provides RAN User Plane Congestion Information (RUCI) to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

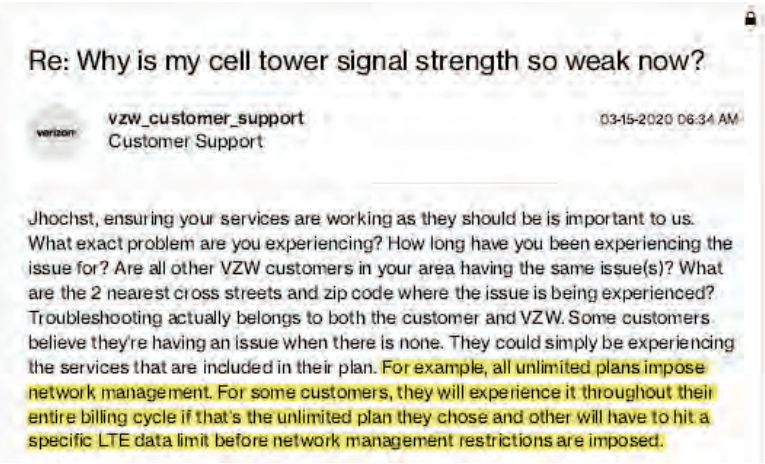
The RCAF collects information related to user plane congestion from the RAN's OAM system based on which the RCAF determines the congestion level (and the identifier) of an eNodeB or E-UTRAN cell.

Via the Nq interface the RCAF determines the UEs served by a congested eNodeB or congested E-UTRAN cell and retrieves the APNs of the active PDN connections of those UEs. The decision whether the RCAF operates on eNodeB or E-UTRAN cell level is up to operator configuration.

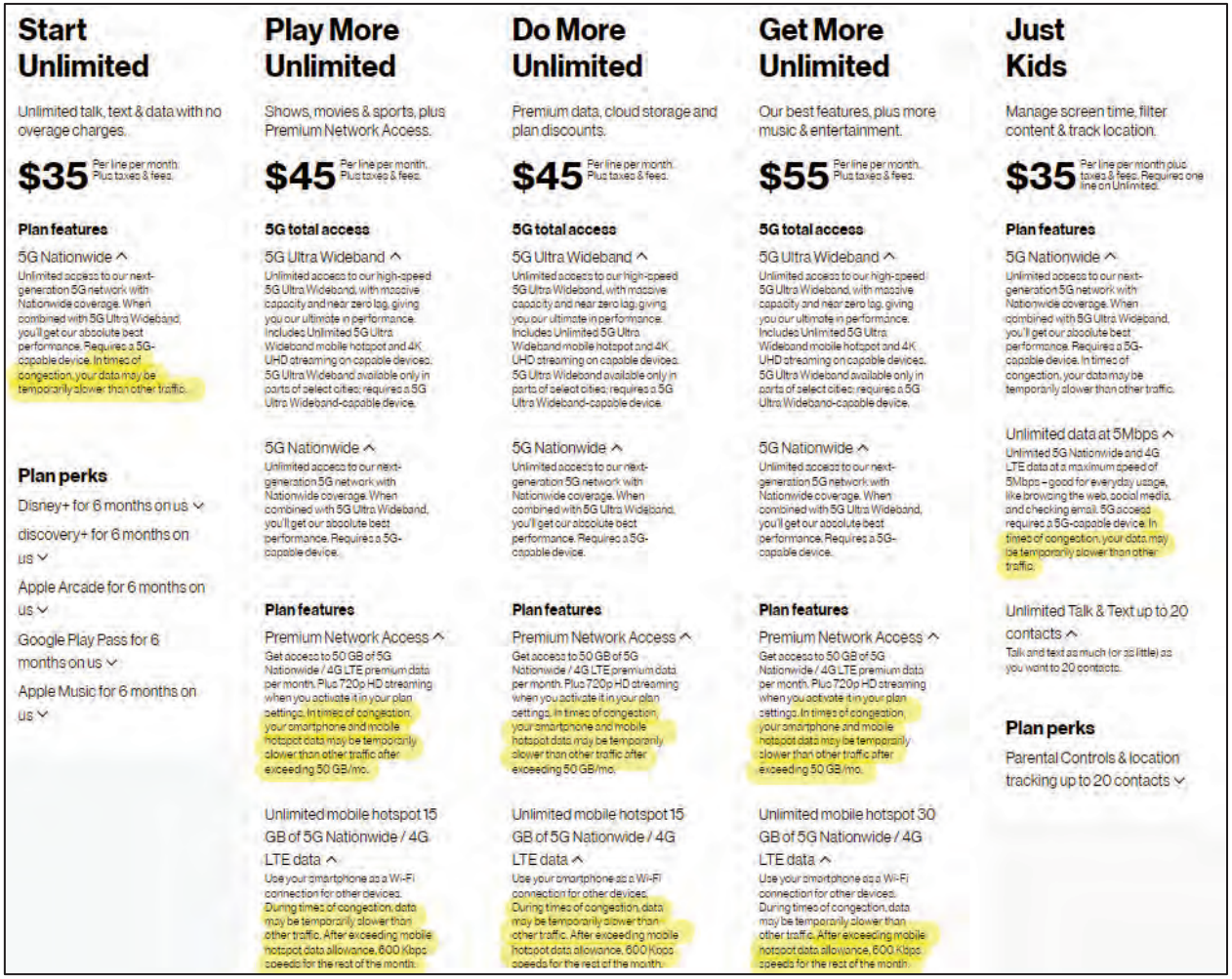
Via the Np reference point, the RCAF sends the RUCI to the PCRFs serving the UEs' PDN connections.

3GPP TS 23.401 at 96-97.

In addition to the use of 4G PCC architecture referenced above, the Verizon operator network adopts the analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving traffic profiles over said network resource for said plurality of devices. *See, e.g.*, 3GPP TS 23.503 at 13 ("It shall be possible with the PCC framework, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control."); *id.* at

	21 (interactions between PCF and AF); *id.* at 26 (policy decisions based on network analytics); *id.* at 33 *and* 46 (application traffic detection); *id.* at 47-48 (policy control based on interface between the PCF, SMF, and AF); *id.* at 65-67 (PCC decisions receive input from AF and NWDAF). In addition to the use of 4G PCC architecture referenced above, the Verizon operator network adopts the analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving traffic profiles over said network resource for said plurality of devices. *See, e.g.*, 3GPP TS 23.503 at 13 ("It shall be possible with the PCC framework, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control."); *id.* at 21 (interactions between PCF and AF); *id.* at 26 (policy decisions based on network analytics); *id.* at 33 *and* 46 (application traffic detection); *id.* at 47-48 (policy control based on interface between the PCF, SMF, and AF); *id.* at 65-67 (PCC decisions receive input from AF and NWDAF).
1[G] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	Verizon's implementation of dynamic allocation of network resources includes performing the step of managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles. Verizon explains how "all unlimited plans impose network management." The network management considers the data allotment relative to specific data billing plans for the devices:  Re: Why is my cell tower signal strength so weak now? vzw_customer_support Customer Support 03-15-2020 06:34 AM Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed.

See https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).



Start Unlimited

Unlimited talk, text & data with no overage charges.

$35 Per line per month. Plus taxes & fees.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Plan perks

Disney+ for 6 months on us

discovery+ for 6 months on us

Apple Arcade for 6 months on us

Google Play Pass for 6 months on us

Apple Music for 6 months on us

Play More Unlimited

Shows, movies & sports, plus Premium Network Access.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Do More Unlimited

Premium data, cloud storage and plan discounts.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Get More Unlimited

Our best features, plus more music & entertainment.

$55 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 30 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Just Kids

Manage screen time, filter content & track location.

$35 Per line per month plus taxes & fees. Requires one line on Unlimited.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited data at 5Mbps

Unlimited 5G Nationwide and 4G LTE data at a maximum speed of 5Mbps – good for everyday usage, like browsing the web, social media, and checking email. 5G access requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited Talk & Text up to 20 contacts

Talk and text as much (or as little) as you want to 20 contacts.

Plan perks

Parental Controls & location tracking up to 20 contacts

VZW Plans.

	Implementing Verizon's Broadband Internet Access Services includes managing the shared network resources according to the service and billing profile of the device selected according to limitation 1[H]. For example, the shared network resource will deliver data according to the service profile and billing profile—which depends, in part, on the customer's priority and whether the resource is congested: On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4. You must be using an approved, network compatible device and be within the Verizon coverage area to access the Verizon network. Whether you experience these speeds depends on many factors, including among others, the type of device, the programs running on the device, your location, and how many other customers are attempting to use the same spectrum resources (including both mobile broadband internet access and other non-broadband internet access services that share the network, such as Private Network Traffic Management, HD Voice, Push to Talk Plus, and MDM). For information on our network and testing of the network, go to https://www.verizon.com/featured/our-network/ (/featured/our-network/) *See, e.g.*, BSI at 3. The 3GPP Standards describe the use of the PCC architecture in Verizon's operator network and other network elements to enforce policy decisions, thereby managing network resources according to service-related and billing-related information set forth in Claims 1[B] and 1[C], as well as traffic-related information set forth in Claim 1[D]. As one example, a PCRF or PCEF may manage a network resource by initiating an IP-CAN modification in response to specific event triggers relating to the network resource.

6.1.4 Event Triggers

The Event Reporting Function (ERF) performs event trigger detection. When an event matching the event trigger occurs, the ERF shall report the occurred event to the PCRF. The Event Reporting Function is located either at the PCEF or, at the BBERF (if applicable) or, at the TDF for solicited application reporting (if applicable).

The event triggers define the conditions when the ERF shall interact again with PCRF after an IP-CAN session establishment. The event triggers that are required in procedures shall be unconditionally reported from the ERF, while the PCRF may subscribe to the remaining events. Whether an event trigger requires a subscription by the PCRF is indicated in column 4 in table 6.2 below.

The PCRF subscribes to new event triggers or remove armed event triggers unsolicited at any time or upon receiving a request from the AF, an event report or rule request from the ERF (PCEF or BBERF or TDF) using the Provision of PCC Rules procedure or the Provision of QoS Rules procedure (if applicable) or the Provision of ADC Rules procedure (if applicable). If the provided event triggers are associated with certain parameter values then the ERF shall include those values in the response back to the PCRF. Event triggers are associated with all rules at the ERF of an IP-CAN session (ERF is located at PCEF) or Gateway Control session (ERF is located at BBERF) or with Traffic Detection session (ERF is located in TDF). Event triggers determine when the ERF shall signal to the PCRF that an IP-CAN bearer has been modified. It shall be possible for the ERF to react on the event triggers listed in table 6.2.

3GPP TS 23.203 at 42.

Network management can be performed, for instance, based on IP-CAN session modification.

7.4 IP-CAN Session Modification

7.4.1 IP-CAN Session Modification; GW (PCEF) initiated

This clause describes the signalling flow for the IP-CAN Session modification initiated by the GW (PCEF). These modifications include IP-CAN bearer establishment and termination as well as modification if the triggering conditions given to the PCEF are fulfilled.

For the PCEF enhanced with ADC, the reason for such a modification may be that a start or stop of application traffic that matches with one of the activated PCC Rules is detected.

The AF may be involved. An example of the scenario is authorization of a session-based service for which an IP-CAN Session is also modified.

3GPP TS 23.203 at 137; *see generally id.* at 137-144 (describing PCEF and PCRF initiated session modification).

	Additionally, network management at the PCRF can be performed, for example, based on information received regarding congestion. 4.3.24 RAN user plane congestion management function 4.3.24.1 General The user plane congestion management function addresses how the system can effectively mitigate RAN user plane congestion in order to reduce the negative impact on the perceived service quality. The congestion mitigation measures include traffic prioritization, traffic reduction and limitation of traffic, and shall be able to manage user plane traffic across a range of variables including the user's subscription, the type of application, and the type of content. Congestion mitigation can be performed in the RAN or in the CN, or in a combined way both in the RAN and in the CN. 3GPP TS 23.401 at 82.

4.3.24.3 RAN user plane congestion mitigation in the CN

RAN user plane congestion mitigation in the CN uses RAN OAM information, collected by the RAN Congestion Awareness Function (RCAF), to detect congestion. The RAN Congestion Awareness Function is further described in clause 4.4.12. This functionality is applicable only in the case of UTRAN/E-UTRAN accesses.

NOTE 1: The criteria used for detection of RAN user plane congestion (including detection of congestion abatement) are outside the scope of 3GPP specifications.

NOTE 2: The interface to the RAN's OAM system is not standardized.

The RCAF can transfer RAN user plane congestion information (RUCI) to the PCRF over the Np reference point in order to mitigate the congestion by measures selected by the PCRF, as specified in TS 23.203 [6]. Decisions to apply congestion mitigation measures may take into account operator policies and subscriber information and all additional available IP-CAN session information.

Different mechanisms and mitigation actions applicable as described in TS 23.203 [6] in order to mitigate RAN User Plane Congestion. Those mechanisms include e.g. service/application gating, service/application bandwidth limitation, deferring of services.

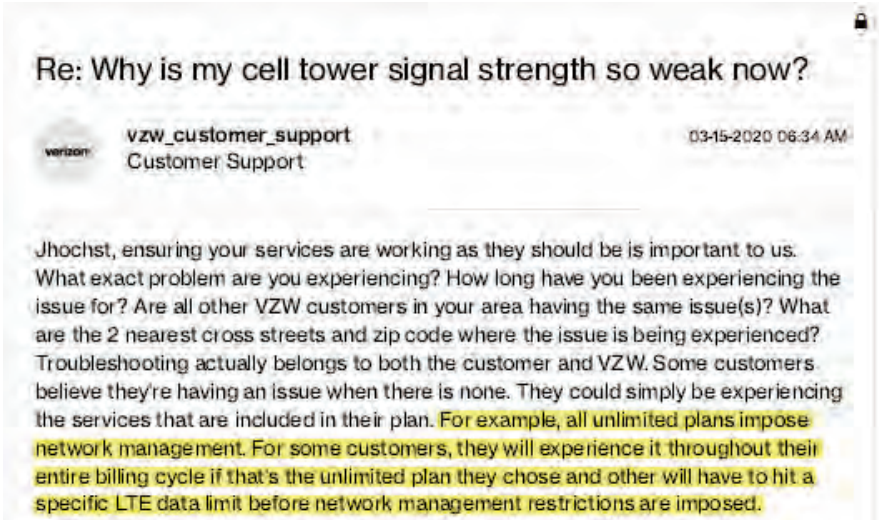
NOTE 3: Co-existence between congestion mitigation in RAN and CN can be assured by appropriate network configuration of applicable policies for congestion mitigation, as well as related RAN parameter alignment/tuning, such as tuning of parameters for e.g., load balancing, carrier aggregation, co-ordinated multipoint, dual connectivity. This parameter alignment/tuning is not further specified.

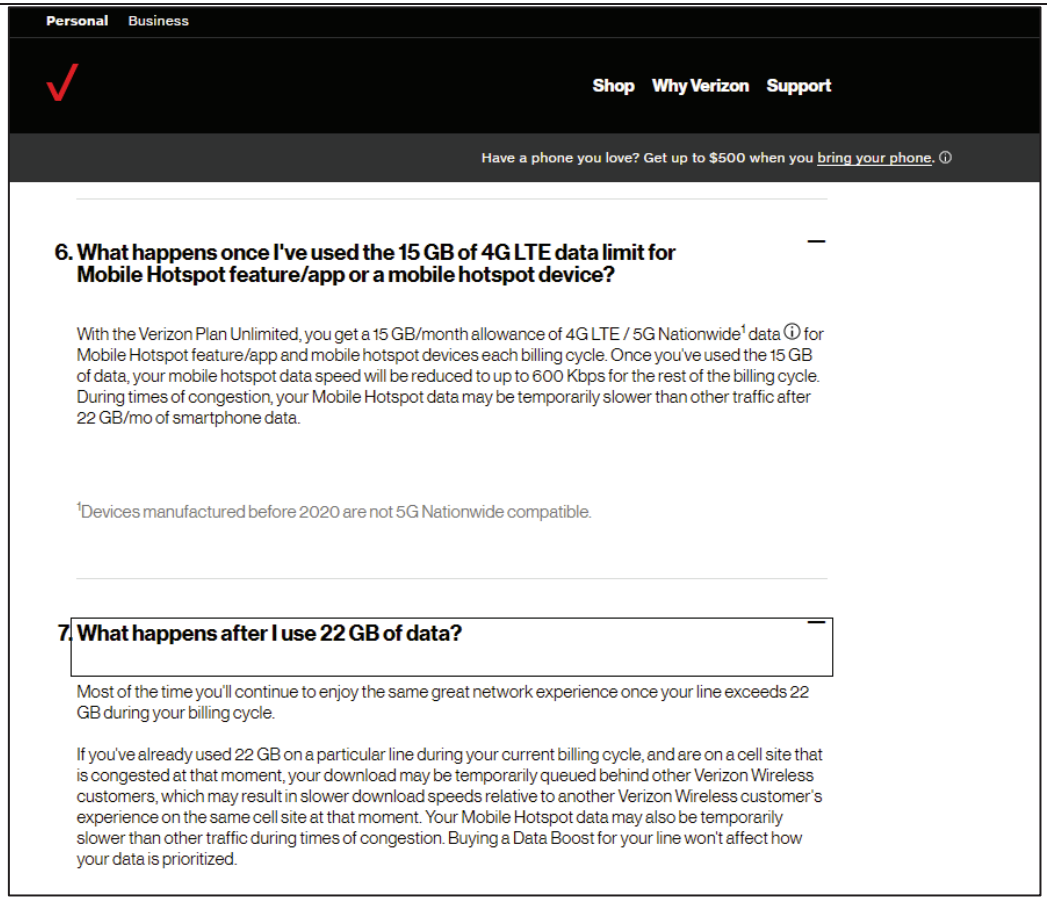
NOTE 4: A condition leading to interoperability issues which may lead to suboptimal situation is that the time scales for actions of congestion mitigation in RAN and in CN are of comparable duration. Therefore, congestion mitigation in RAN and CN cannot have comparable time scales, otherwise interoperability is affected.

3GPP TS 23.401 at 83.

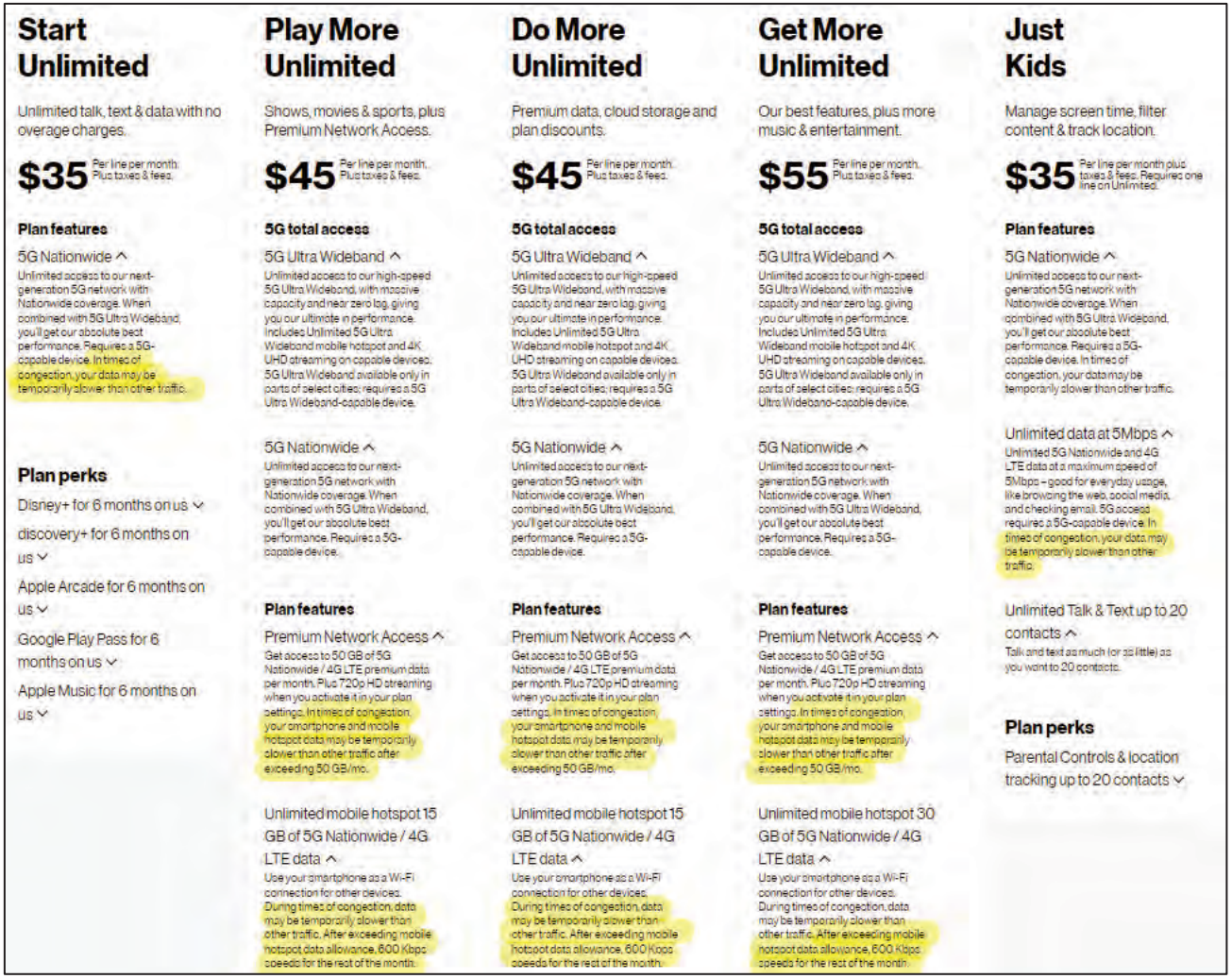
See also 1[F] (detailing the RCAF reporting).

	The PCC architecture makes policy decisions based on subscriber information and traffic profile information. It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control. It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling. The PCC architecture shall support making policy decisions based on subscriber spending limits. The PCC architecture shall support making policy decisions based on RAN user plane congestion status. The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43]. The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering. 3GPP TS 23.203 at 21. In addition to the use of 4G PCC architecture referenced above, the Verizon network adopts the analogous PCC framework from the 3GPP Standards for its 5G mobile network to support control of PDU Sessions, thereby implementing a method for managing network resources according to service-related and billing-related information set forth in Claims 1[B] and 1[C], as well as traffic-related information set forth in Claim 1[F]. *See, e.g.*, 3GPP TS 23.503 at 15-16 (QoS control requirements); *id.* at 71-74 (QoS control and PDU Session modification at SMF based on usage monitoring).
1[H] selecting at least one of said devices based on said prioritizatio n list and	Verizon's implementation of dynamic allocation of network resources includes performing the step of selecting at least one of said devices based on said prioritization list. *See* limitation 1[D] above regarding prioritization lists and using prioritization list to limit data rates of specific Verizon customers. Implementing Verizon's Broadband Internet Access Services includes selecting at least one of the devices for prioritization. *See, e.g.*, 1[D] above *and* NM at 2 (explaining that Verizon "may prioritize your 5G Nationwide and 4G LTE data behind other traffic" as a result of network management); IPI at 1 ("During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic . . . .").

	Verizon also indicates it manages its network by selecting customers who have a lower priority Rate Plan:  Re: Why is my cell tower signal strength so weak now? vzw_customer_support Customer Support 03-15-2020 06:34 AM Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed. *See* https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).
1[I] dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network	Verizon's implementation of dynamic allocation of network resources includes performing the step of dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles. Implementing Verizon's Broadband Internet Access Services includes dynamically modifying at least the service profile(s) (e.g., bit-rate cap, data volume cap, etc.) by adjusting the data speeds when the resource is over utilized by the customer's data requests:

resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles;	 https://www.verizon.com/support/verizon-plan-unlimited-faqs/ (last visited Dec. 8, 2021). On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4.

Further, Verizon adjusts bit-data rates of customers (using part of the customer's service profile and billing profile) according to a customer's Rate Plan and/or when a customer exceeds the data volume caps of a customer's Data Plan:



Start Unlimited

Unlimited talk, text & data with no overage charges.

$35 Per line per month. Plus taxes & fees.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Plan perks

Disney+ for 6 months on us

discovery+ for 6 months on us

Apple Arcade for 6 months on us

Google Play Pass for 6 months on us

Apple Music for 6 months on us

Play More Unlimited

Shows, movies & sports, plus Premium Network Access.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Do More Unlimited

Premium data, cloud storage and plan discounts.

$45 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 15 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Get More Unlimited

Our best features, plus more music & entertainment.

$55 Per line per month. Plus taxes & fees.

5G total access

5G Ultra Wideband

Unlimited access to our high-speed 5G Ultra Wideband, with massive capacity and near zero lag, giving you our ultimate in performance. Includes Unlimited 5G Ultra Wideband mobile hotspot and 4K UHD streaming on capable devices. 5G Ultra Wideband available only in parts of select cities; requires a 5G Ultra Wideband-capable device.

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device.

Plan features

Premium Network Access

Get access to 50 GB of 5G Nationwide / 4G LTE premium data per month. Plus 720p HD streaming when you activate it in your plan settings. In times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic after exceeding 50 GB/mo.

Unlimited mobile hotspot 30 GB of 5G Nationwide / 4G LTE data

Use your smartphone as a Wi-Fi connection for other devices. During times of congestion, data may be temporarily slower than other traffic. After exceeding mobile hotspot data allowance, 600 Kbps speeds for the rest of the month.

Just Kids

Manage screen time, filter content & track location.

$35 Per line per month plus taxes & fees. Requires one line on Unlimited.

Plan features

5G Nationwide

Unlimited access to our next-generation 5G network with Nationwide coverage. When combined with 5G Ultra Wideband, you'll get our absolute best performance. Requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

Unlimited data at 5Mbps

Unlimited 5G Nationwide and 4G LTE data at a maximum speed of 5Mbps – good for everyday usage, like browsing the web, social media, and checking email. 5G access requires a 5G-capable device. In times of congestion, your data may be temporarily slower than other traffic.

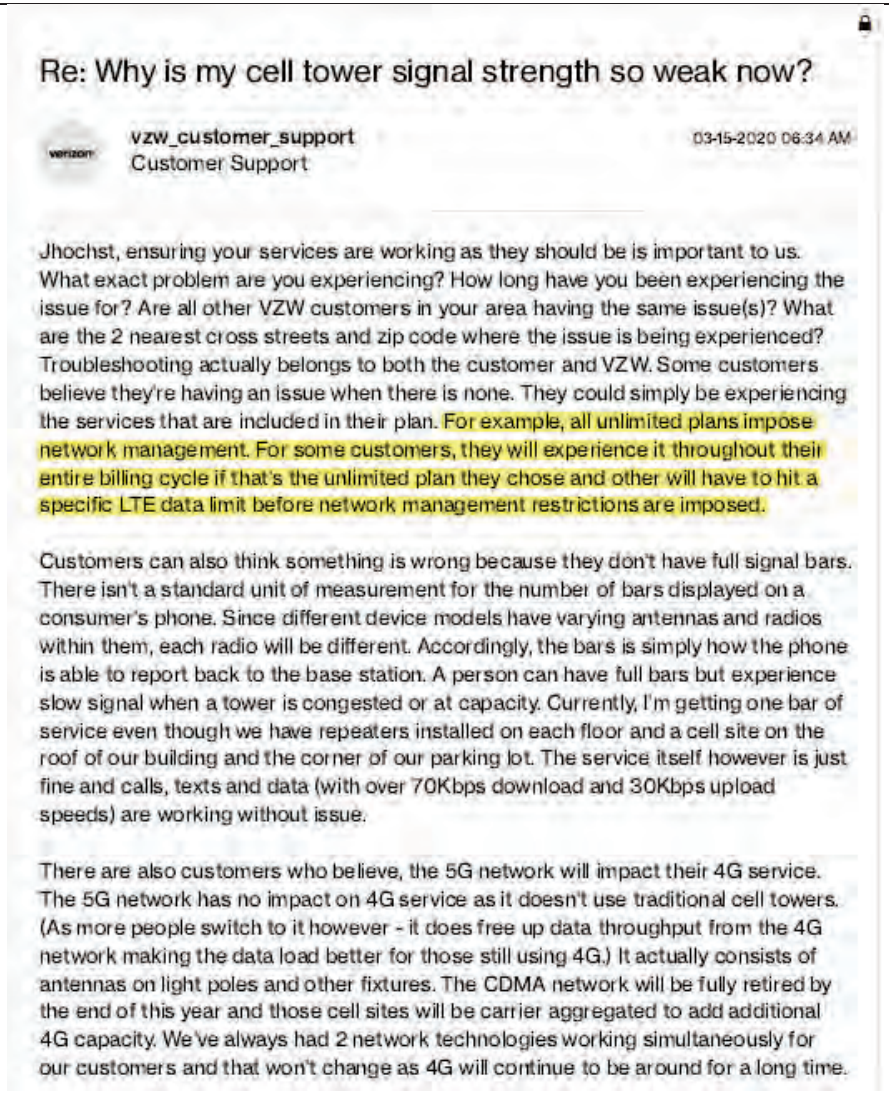
Unlimited Talk & Text up to 20 contacts

Talk and text as much (or as little) as you want to 20 contacts.

Plan perks

Parental Controls & location tracking up to 20 contacts

VZW Plans.



Re: Why is my cell tower signal strength so weak now?

vzw_customer_support
Customer Support

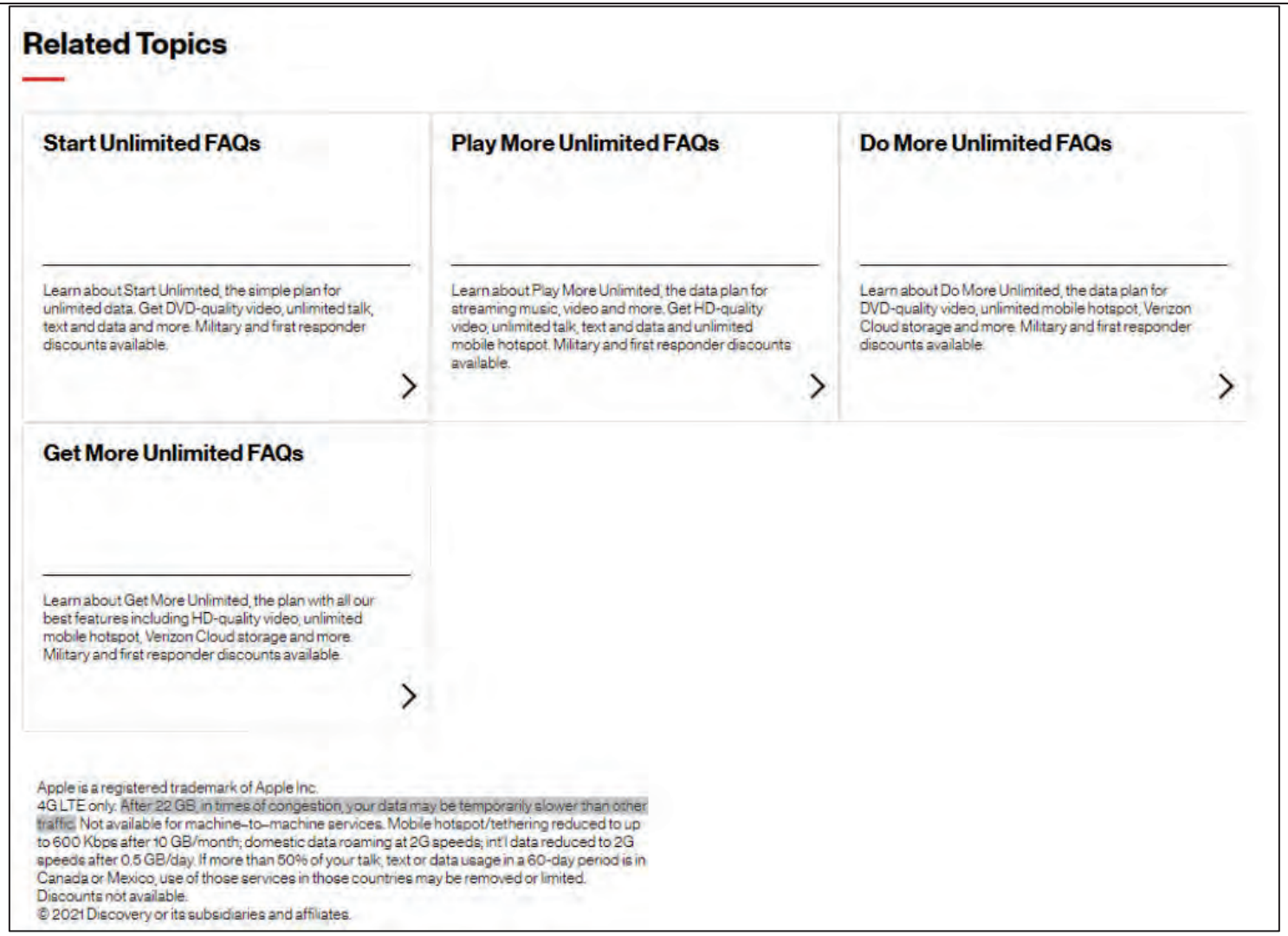
03-15-2020 06:34 AM

Jhochst, ensuring your services are working as they should be is important to us. What exact problem are you experiencing? How long have you been experiencing the issue for? Are all other VZW customers in your area having the same issue(s)? What are the 2 nearest cross streets and zip code where the issue is being experienced? Troubleshooting actually belongs to both the customer and VZW. Some customers believe they're having an issue when there is none. They could simply be experiencing the services that are included in their plan. For example, all unlimited plans impose network management. For some customers, they will experience it throughout their entire billing cycle if that's the unlimited plan they chose and other will have to hit a specific LTE data limit before network management restrictions are imposed.

Customers can also think something is wrong because they don't have full signal bars. There isn't a standard unit of measurement for the number of bars displayed on a consumer's phone. Since different device models have varying antennas and radios within them, each radio will be different. Accordingly, the bars is simply how the phone is able to report back to the base station. A person can have full bars but experience slow signal when a tower is congested or at capacity. Currently, I'm getting one bar of service even though we have repeaters installed on each floor and a cell site on the roof of our building and the corner of our parking lot. The service itself however is just fine and calls, texts and data (with over 70Kbps download and 30Kbps upload speeds) are working without issue.

There are also customers who believe, the 5G network will impact their 4G service. The 5G network has no impact on 4G service as it doesn't use traditional cell towers. (As more people switch to it however - it does free up data throughput from the 4G network making the data load better for those still using 4G.) It actually consists of antennas on light poles and other fixtures. The CDMA network will be fully retired by the end of this year and those cell sites will be carrier aggregated to add additional 4G capacity. We've always had 2 network technologies working simultaneously for our customers and that won't change as 4G will continue to be around for a long time.

See https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).



Related Topics

Start Unlimited FAQs

Learn about Start Unlimited, the simple plan for unlimited data. Get DVD-quality video, unlimited talk, text and data and more. Military and first responder discounts available.

Play More Unlimited FAQs

Learn about Play More Unlimited, the data plan for streaming music, video and more. Get HD-quality video, unlimited talk, text and data and unlimited mobile hotspot. Military and first responder discounts available.

Do More Unlimited FAQs

Learn about Do More Unlimited, the data plan for DVD-quality video, unlimited mobile hotspot, Verizon Cloud storage and more. Military and first responder discounts available.

Get More Unlimited FAQs

Learn about Get More Unlimited, the plan with all our best features including HD-quality video, unlimited mobile hotspot, Verizon Cloud storage and more. Military and first responder discounts available.

Apple is a registered trademark of Apple Inc.
4G LTE only. After 22 GB, in times of congestion, your data may be temporarily slower than other traffic. Not available for machine-to-machine services. Mobile hotspot/tethering reduced to up to 600 Kbps after 10 GB/month; domestic data roaming at 2G speeds; int'l data reduced to 2G speeds after 0.5 GB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. Discounts not available.
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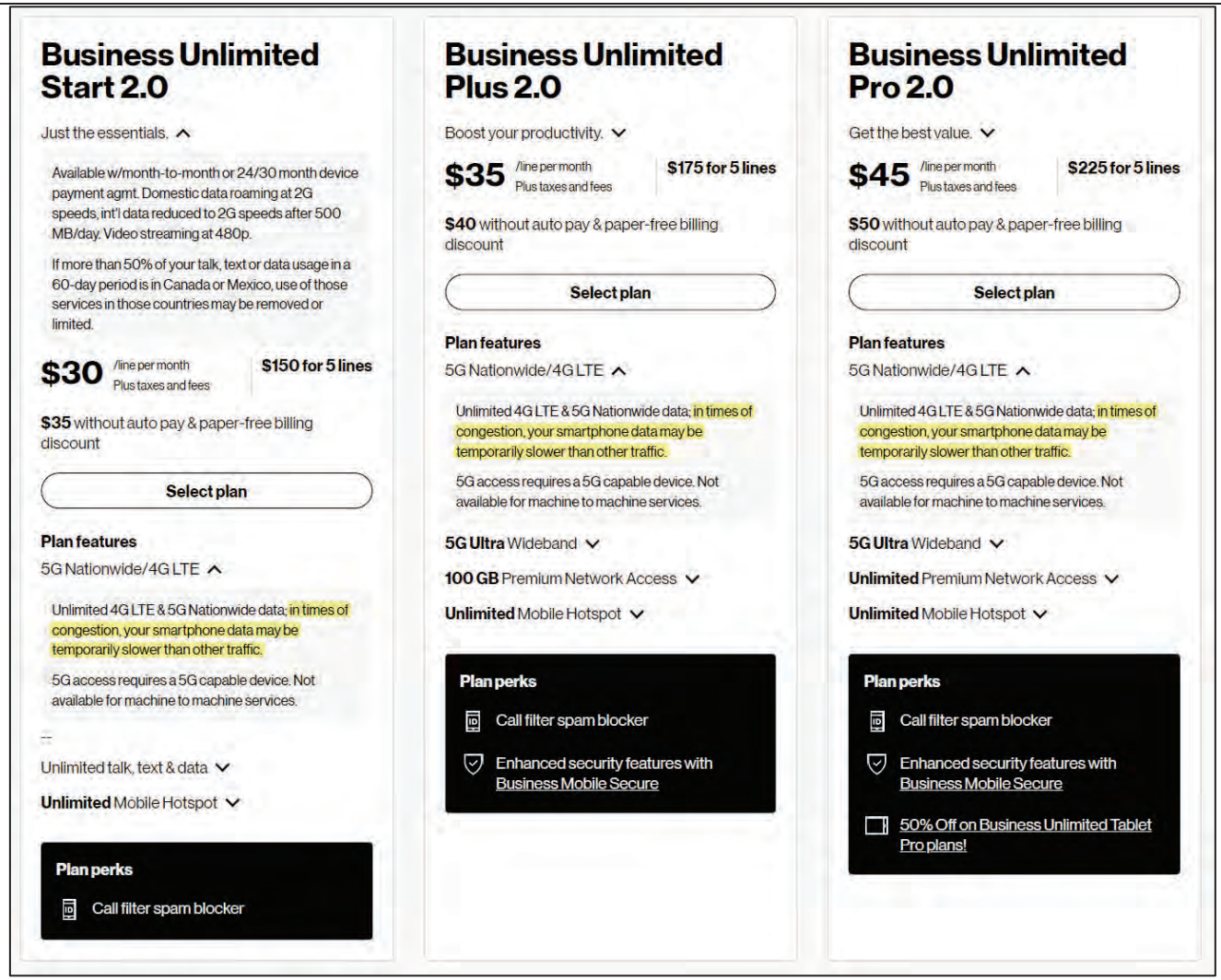
https://www.verizon.com/support/verizon-plan-unlimited-faqs/ (last visited Nov. 1, 2021).



Business Unlimited Start 2.0

Just the essentials.

Available w/month-to-month or 24/30 month device payment agmt. Domestic data roaming at 2G speeds, int'l data reduced to 2G speeds after 500 MB/day. Video streaming at 480p.

If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited.

$30 /line per month Plus taxes and fees | **$150 for 5 lines**

$35 without auto pay & paper-free billing discount

Select plan

Plan features

5G Nationwide/4G LTE

Unlimited 4G LTE & 5G Nationwide data; in times of congestion, your smartphone data may be temporarily slower than other traffic.

5G access requires a 5G capable device. Not available for machine to machine services.

--

Unlimited talk, text & data

Unlimited Mobile Hotspot

Plan perks

Call filter spam blocker

Business Unlimited Plus 2.0

Boost your productivity.

$35 /line per month Plus taxes and fees | **$175 for 5 lines**

$40 without auto pay & paper-free billing discount

Select plan

Plan features

5G Nationwide/4G LTE

Unlimited 4G LTE & 5G Nationwide data; in times of congestion, your smartphone data may be temporarily slower than other traffic.

5G access requires a 5G capable device. Not available for machine to machine services.

5G Ultra Wideband

100 GB Premium Network Access

Unlimited Mobile Hotspot

Plan perks

Call filter spam blocker

Enhanced security features with Business Mobile Secure

Business Unlimited Pro 2.0

Get the best value.

$45 /line per month Plus taxes and fees | **$225 for 5 lines**

$50 without auto pay & paper-free billing discount

Select plan

Plan features

5G Nationwide/4G LTE

Unlimited 4G LTE & 5G Nationwide data; in times of congestion, your smartphone data may be temporarily slower than other traffic.

5G access requires a 5G capable device. Not available for machine to machine services.

5G Ultra Wideband

Unlimited Premium Network Access

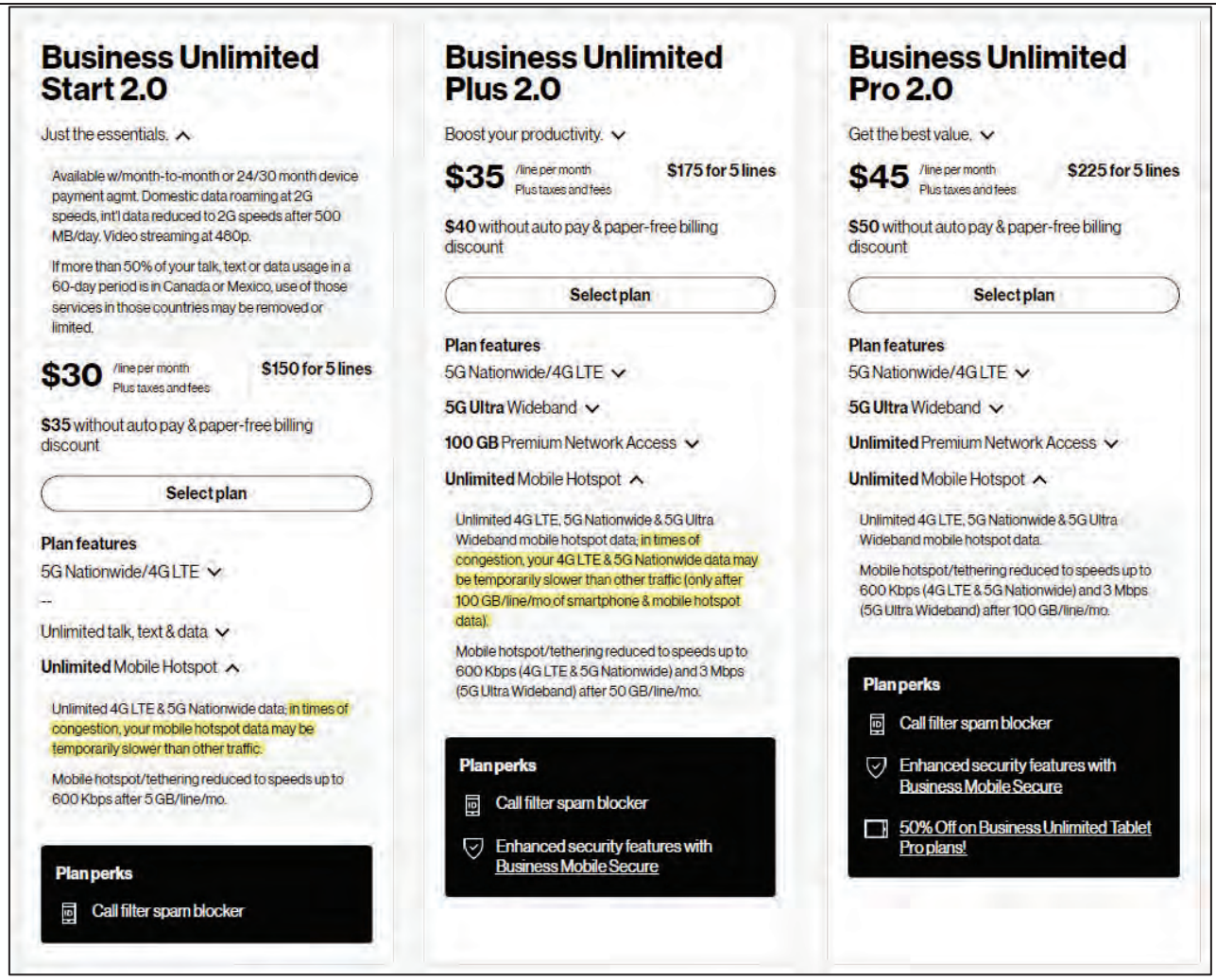
Unlimited Mobile Hotspot

Plan perks

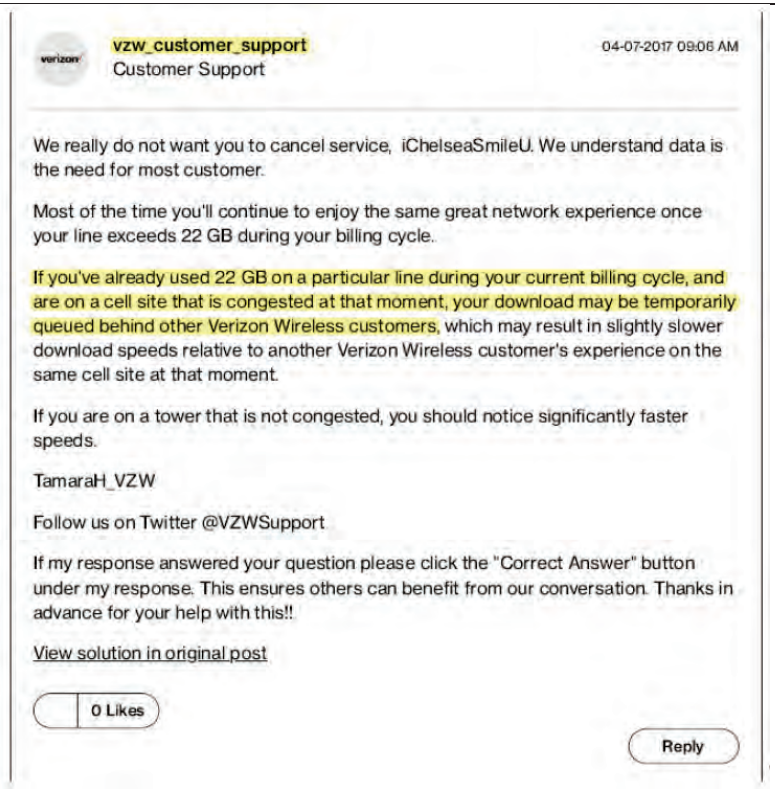
Call filter spam blocker

Enhanced security features with Business Mobile Secure

50% Off on Business Unlimited Tablet Pro plans!



https://www.verizon.com/business/products/plans/business-unlimited/ (last visited Dec. 8, 2021).



vzw_customer_support
Customer Support

04-07-2017 09:06 AM

We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer.

Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle.

If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment.

If you are on a tower that is not congested, you should notice significantly faster speeds.

TamaraH_VZW

Follow us on Twitter @VZWSupport

If my response answered your question please click the "Correct Answer" button under my response. This ensures others can benefit from our conversation. Thanks in advance for your help with this!!

View solution in original post

0 Likes

Reply

https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).

The PCRF makes control decisions that result in modifying a service profile and or billing profile.

> 6.2.1 Policy Control and Charging Rules Function (PCRF)
>
> 6.2.1.0 General
>
> The PCRF encompasses policy control decision and flow based charging control functionalities.
>
> The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF.
>
> The PCRF provides network control regarding the application detection, gating, QoS and application based charging (except credit management) towards the TDF and the PCEF enhanced with ADC.
>
> The PCRF shall apply the security procedures, as required by the operator, before accepting service information from the AF.
>
> The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information.
>
> The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile.
>
> If Gxx applies, the PCRF shall provide QoS rules with identical service data flow templates as provided to the PCEF in the PCC rules. If the service data flow is tunnelled at the BBERF, the PCRF shall provide the BBERF with information received from the PCEF to enable the service data flow detection in the mobility tunnel at the BBERF. In case 2a,

3GPP TS 23.203 at 71.

> The PCRF may check that the service information provided by the AF is consistent with both the operator defined policy rules and the related subscription information as received from the SPR during IP-CAN session establishment before storing the service information. The service information shall be used to derive the QoS for the service. The PCRF may reject the request received from the AF when the service information is not consistent with either the related subscription information or the operator defined policy rules and as a result the PCRF shall indicate that this service information is not covered by the subscription information or by operator defined policy rules and may indicate, in the response to the AF, the service information that can be accepted by the PCRF (e.g. the acceptable bandwidth). In the absence of other policy control mechanisms outside the scope of PCC, it is recommended that the PCRF include this information in the response.

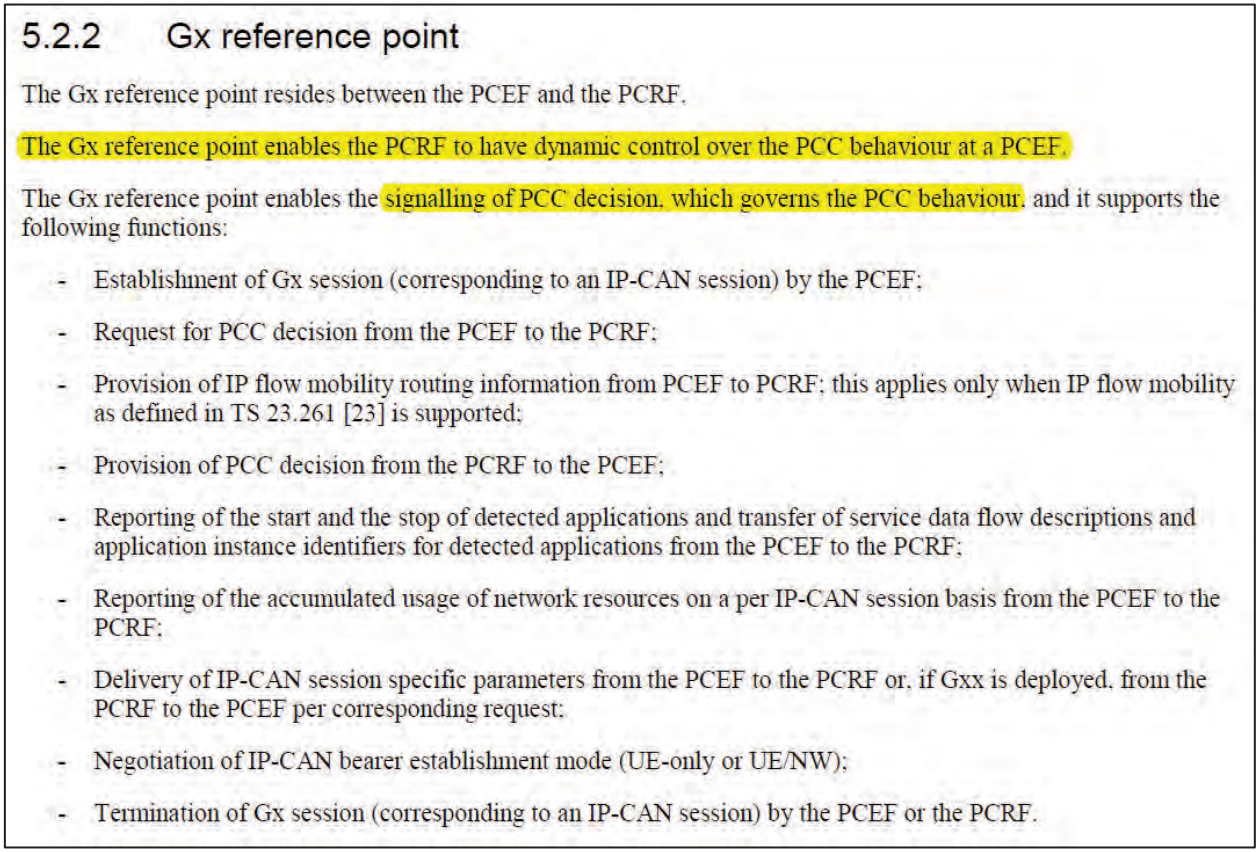
3GPP TS 23.203 at 72.

	Such dynamic modifications may be based on, for example, a dynamic PCC rule, policy control, QoS class identifier, and/or subscriber guaranteed bandwidth QoS. **dynamic PCC Rule**: a PCC rule, for which the definition is provided to the PCEF via the Gx reference point. **policy control**: The process whereby the PCRF indicates to the PCEF how to control the IP-CAN bearer. Policy control includes QoS control and/or gating control. **QoS class identifier (QCI):** A scalar that is used as a reference to a specific packet forwarding behaviour (e.g. packet loss rate, packet delay budget) to be provided to a SDF. This may be implemented in the access network by the QCI referencing node specific parameters that control packet forwarding treatment (e.g. scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration, etc.), that have been pre-configured by the operator at a specific node(s) (e.g. eNodeB). **subscribed guaranteed bandwidth QoS**: The per subscriber, authorized cumulative guaranteed bandwidth QoS which is provided by the SPR/UDR to the PCRF. 3GPP TS 23.203 at 17-18.

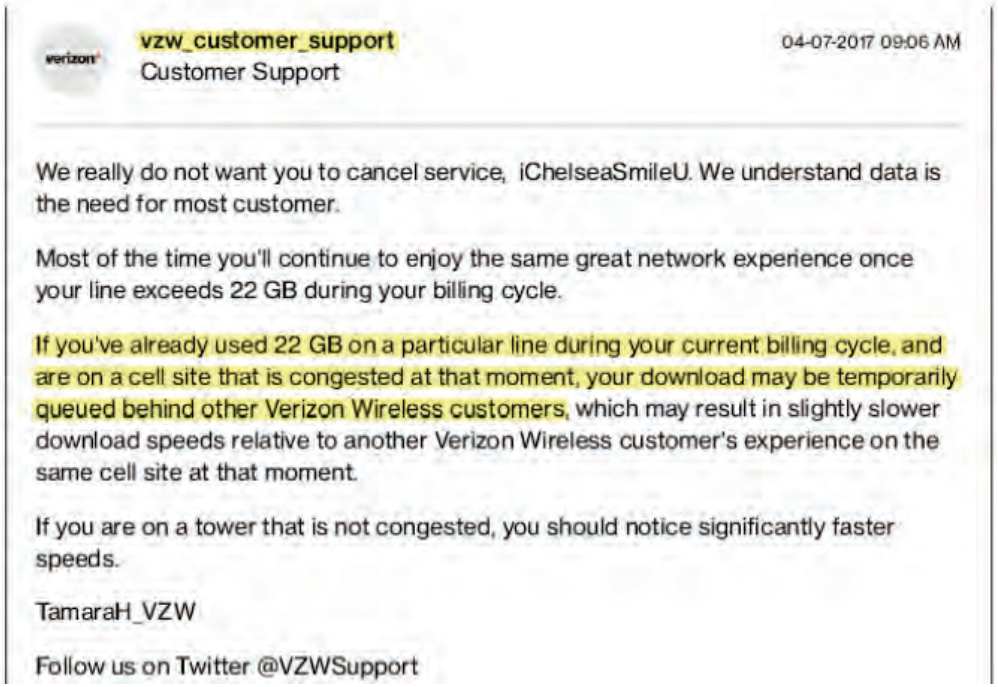
	The PCC architecture shall allow the charging control to be applied on a per service data flow and on a per application basis, independent of the policy control. The PCC architecture shall have a binding method that allows the unique association between service data flows and their IP-CAN bearer. A single service data flow detection shall suffice for the purpose of both policy control and flow based charging. A PCC rule may be predefined or dynamically provisioned at establishment and during the lifetime of an IP-CAN session. The latter is referred to as a dynamic PCC rule. The number of real-time PCC interactions shall be minimized although not significantly increasing the overall system reaction time. This requires optimized interfaces between the PCC nodes. It shall be possible to take a PCC rule into service, and out of service, at a specific time of day, without any PCC interaction at that point in time. It shall be possible to take APN-related policy information into service, and out of service, once validity conditions specified as part of the APN-related policy information are fulfilled or not fulfilled anymore, respectively, without any PCC interaction at that point in time. PCC shall be enabled on a per PDN basis (represented by an access point and the configured range of IP addresses) at the PCEF. It shall be possible for the operator to configure the PCC architecture to perform charging control, policy control or both for a PDN access. PCC shall support roaming users. The PCC architecture shall allow the resolution of conflicts which would otherwise cause a subscriber's Subscribed Guaranteed Bandwidth QoS to be exceeded. 3GPP TS 23.203 at 20.

	The PCC architecture shall support topology hiding. It should be possible to use PCC architecture for handling IMS-based emergency service and Restricted Local Operator Services. It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control. It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling. The PCC architecture shall support making policy decisions based on subscriber spending limits. The PCC architecture shall support making policy decisions based on RAN user plane congestion status. The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43]. The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering. 3GPP TS 23.203 at 21.

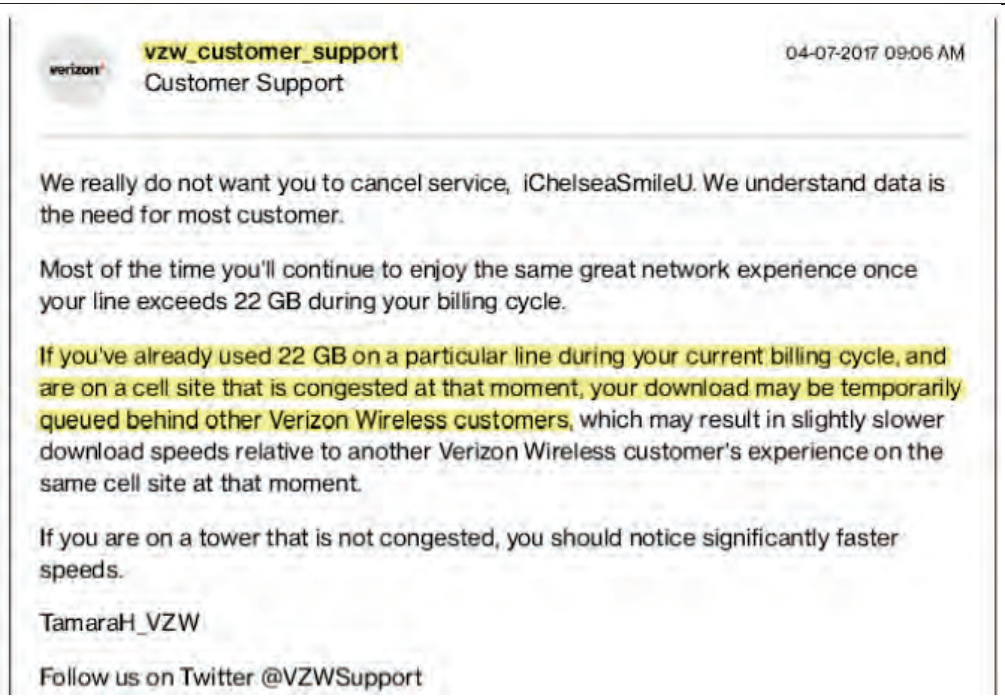
	The PCRF implements dynamic policy decisions. **4.4 Usage Monitoring Control** It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per IP-CAN session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time. The PCRF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the PCEF or TDF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCRF may send both thresholds to the PCEF or TDF. The PCEF or TDF shall notify the PCRF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the PCEF or TDF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached. NOTE: There are reasons other than reaching a threshold that may cause the PCEF/TDF to report accumulated usage to the PCRF as defined in clauses 6.2.2.3 and 6.6.2. The usage monitoring capability shall be possible for an individual or a group of service data flow(s), or for all traffic of an IP-CAN session in the PCEF. When usage monitoring for all traffic of an IP-CAN session is enabled, it shall be possible to exclude an individual SDF or a group of service data flow(s) from the usage monitoring for all traffic of this IP-CAN session. It shall be possible to activate usage monitoring both to service data flows associated with predefined PCC rules and dynamic PCC rules, including rules with deferred activation and/or deactivation times while those rules are active. 3GPP TS 23.203 at 25.

	 5.2.2 Gx reference point The Gx reference point resides between the PCEF and the PCRF. The Gx reference point enables the PCRF to have dynamic control over the PCC behaviour at a PCEF. The Gx reference point enables the signalling of PCC decision, which governs the PCC behaviour, and it supports the following functions: - Establishment of Gx session (corresponding to an IP-CAN session) by the PCEF; - Request for PCC decision from the PCEF to the PCRF; - Provision of IP flow mobility routing information from PCEF to PCRF; this applies only when IP flow mobility as defined in TS 23.261 [23] is supported; - Provision of PCC decision from the PCRF to the PCEF; - Reporting of the start and the stop of detected applications and transfer of service data flow descriptions and application instance identifiers for detected applications from the PCEF to the PCRF; - Reporting of the accumulated usage of network resources on a per IP-CAN session basis from the PCEF to the PCRF; - Delivery of IP-CAN session specific parameters from the PCEF to the PCRF or, if Gxx is deployed, from the PCRF to the PCEF per corresponding request; - Negotiation of IP-CAN bearer establishment mode (UE-only or UE/NW); - Termination of Gx session (corresponding to an IP-CAN session) by the PCEF or the PCRF. 3GPP TS 23.203 at 31.

	The enforcement of the authorized QoS of the IP-CAN bearer may lead to a downgrading or upgrading of the requested bearer QoS by the GW (PCEF) as part of a UE-initiated IP-CAN bearer establishment or modification. Alternatively, the enforcement of the authorised QoS may, depending on operator policy and network capabilities, lead to network initiated IP-CAN bearer establishment or modification. If the PCRF provides authorized QoS for both, the IP-CAN bearer and PCC rule(s), the enforcement of authorized QoS of the individual PCC rules shall take place first. QoS authorization information may be dynamically provisioned by the PCRF or, if the conditions mentioned in clause 6.3.1 apply, it can be a predefined PCC rule in the PCEF. In case the PCRF provides PCC rules dynamically, authorised QoS information for the IP-CAN bearer (combined QoS) may be provided. For a predefined PCC rules within the PCEF the authorized QoS information shall take affect when the PCC rule is activated. The PCEF shall combine the different sets of authorized QoS information, i.e. the information received from the PCRF and the information corresponding to the predefined PCC rules. The PCRF shall know the authorized QoS information of the predefined PCC rules and shall take this information into account when activating them. This ensures that the combined authorized QoS of a set of PCC rules that are activated by the PCRF is within the limitations given by the subscription and operator policies regardless of whether these PCC rules are dynamically provided, predefined or both. 3GPP TS 23.203 at 48. In addition to the use of 4G PCC architecture referenced above, the Verizon network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles. *See, e.g.*, 3GPP TS 23.503 at 17; *see also, e.g.*, 3GPP TS 23.503 at 9 (authorized QoS flow, dynamic PCC rule, PCC decision, policy control, and subscribed guaranteed bandwidth QoS for 5G systems); *id.* at 60-62 (Policy Control Function); *id.* at 66-69 (Policy control subscription information management describing changes in subscription information); *id.* at 78-84, 88-89 (modification of dynamic PCC rules).
1[J] until said plurality of devices no longer continue to share said network	Verizon's implementation of dynamic allocation of network resources includes repeating the steps 1[F]-1[I] until said plurality of devices no longer continue to share said network resource. Implementing Verizon's Broadband Internet Access Services includes prioritizing the data traffic by repeating 1[F]-1[I] until the plurality of devices no longer continue to share said network resource. For example, Verizon will not manage a customer's traffic profile according to a network resource that the customer is no longer using. *See, e.g.*, BSI at 3-4 ("Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal."). Verizon indicates it adjusts the data rates of its users using a prioritization scheme that "temporarily" queues certain customers behind others during congestion, but maintains faster data rates on cell sites that are not congested:

resource; and	 https://community.verizon.com/t5/Verizon-Wireless-Services/Is-data-prioritization-supposed-to-make-your-dataplan-basically/td-p/995275 (last visited Nov. 1, 2021). As part of congestion reporting (*see* 1[F]), "the RCAF detects that the UE is no longer experiencing congestion (i.e. the UE is no longer detected in any of the congested cells that the RCAF is monitoring)." 3GPP TS 29.217 version 16.0.0 Release 16, at 10 (2020-08).

	The PCRF maintains session information until it is terminated. 6.2.1.2 Subscription information management in the PCRF The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination. The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted. 3GPP TS 23.203 at 79; *see also id.* at 132, 135 (detailing IP-CAN Session Termination).
1[K] when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	Verizon's implementation of dynamic allocation of network resources includes performing the step of, when said plurality of devices are no longer sharing said network resource, clearing said prioritization list. Implementing Verizon's Broadband Internet Access Services includes clearing the prioritization list when the plurality of devices are no longer sharing the network resource (*i.e.*, the prioritization list is not generated when there is no traffic over a network resource). *See, e.g.*, BSI at 3-4 ("Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal."). When a device is not accessing the Verizon network or when it moves to a different base station or cell tower, it will be removed from the prioritization list associated with the prior base station or cell tower:



vzw_customer_support
Customer Support

04-07-2017 09:06 AM

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Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle.

If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment.

If you are on a tower that is not congested, you should notice significantly faster speeds.

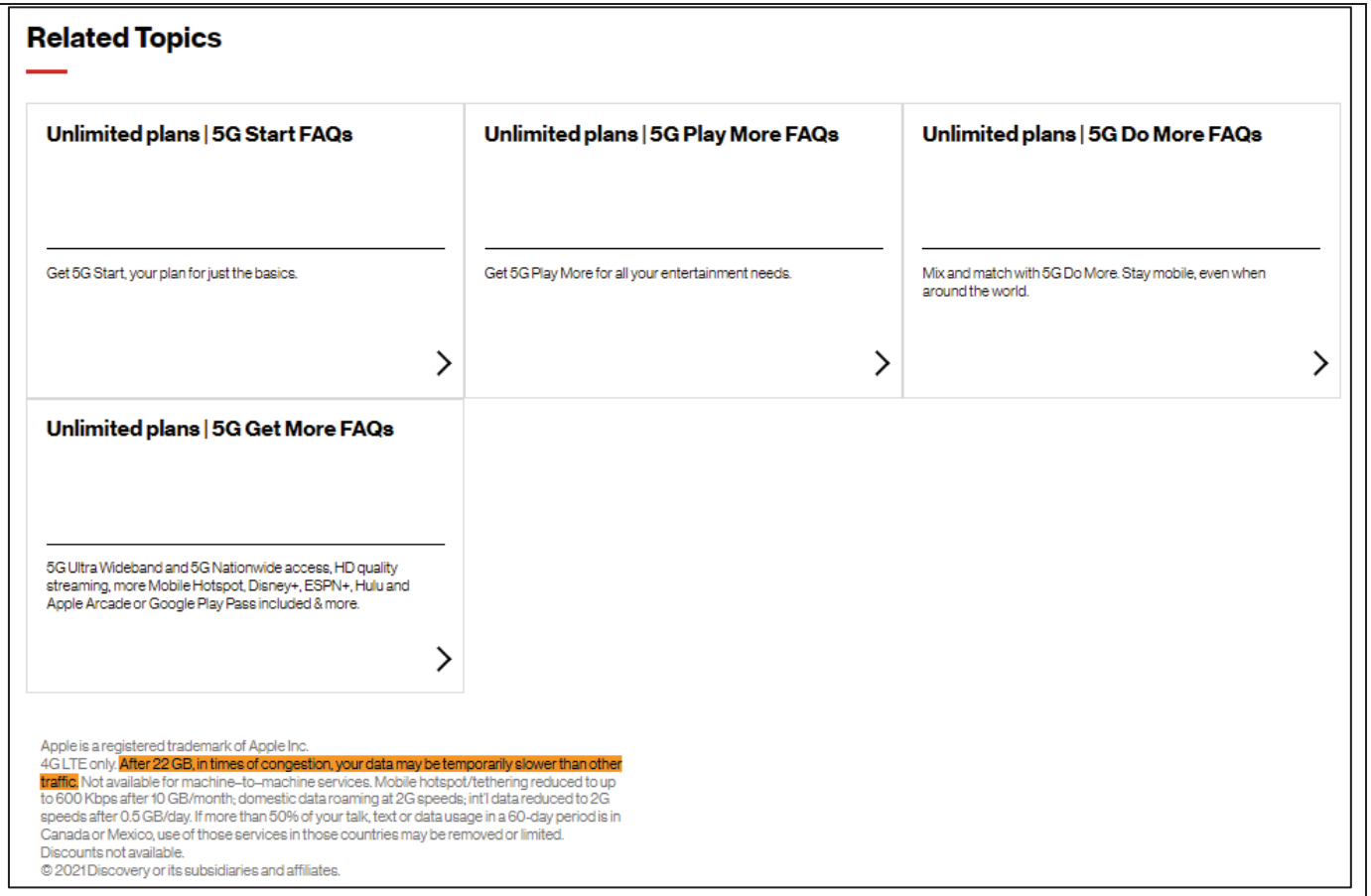
TamaraH_VZW

Follow us on Twitter @VZWSupport

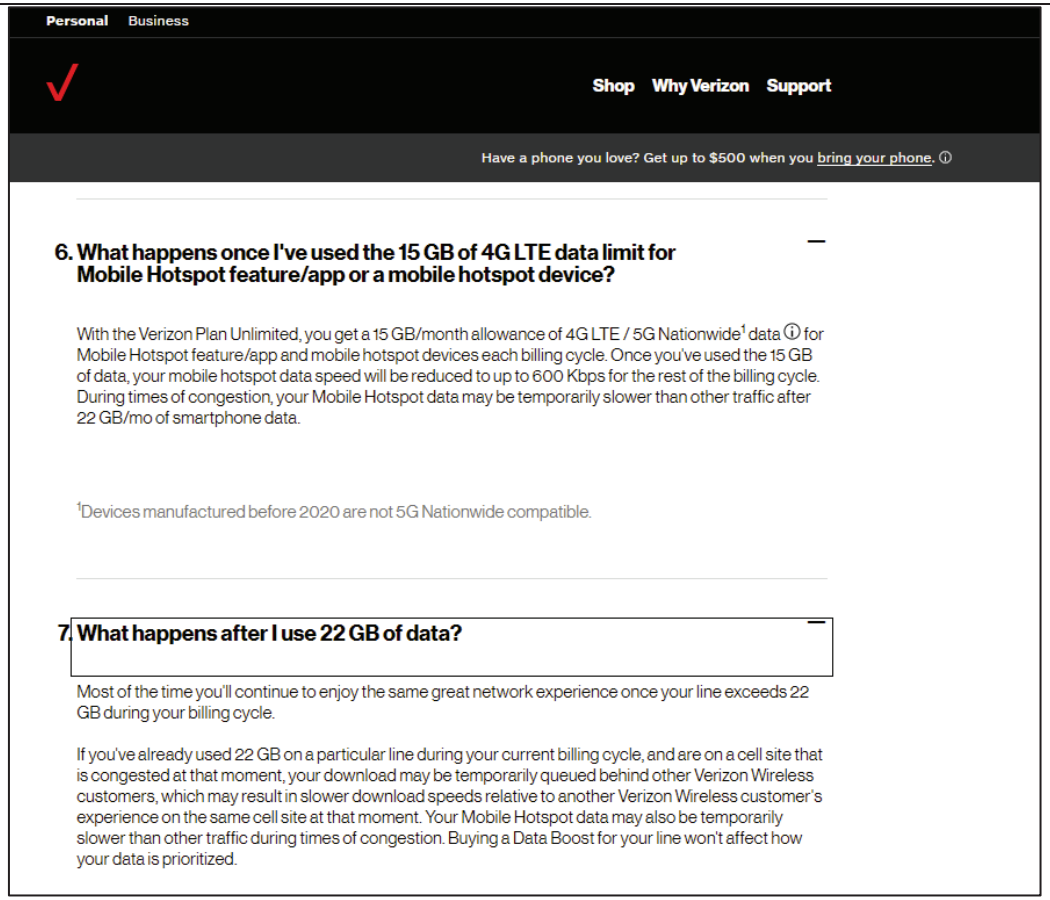
https://community.verizon.com/t5/Verizon-Wireless-Services/Is-data-prioritization-supposed-to-make-your-dataplan-basically/td-p/995275 (last visited Nov. 1, 2021).

	The PCRF maintains session information until it is terminated. 6.2.1.2 Subscription information management in the PCRF The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination. The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted. 3GPP TS 23.203 at 79; *see also id.* at 132, 135 (detailing IP-CAN Session Termination).

CLAIM 2	'813 PATENT V. VERIZON
2[A]. The method of claim 1 wherein said dynamically modifying comprises increasing or reducing an overall bit-rate cap or data volume cap in a service profile for at least one of said devices.	Verizon's implementation of dynamic allocation of network resources includes increasing or reducing an overall bit-rate cap or data volume cap in a service profile for at least one of said devices. *See* 1[I] (explaining that the network management "may result in slower data speeds"), which is incorporated here by reference. As noted above in Claim 1, the Verizon cellular network modifies a customer's bit-rate cap when data volume caps are exceeded during a monthly billing cycle. Exceeding those data volume caps results in deprioritized services for a Verizon customer during periods of network congestion. Similarly, Verizon imposes data volume caps for hotspot or tethering usage. In at least certain instances, the lower priority customers will be limited to a bit-rate cap of 2G or 3G speeds. In addition, a customer's bit-rate cap may be increased even when a monthly data volume cap has been exceeded, in instances where the Verizon network is lightly loaded. Verizon explains the speed reductions (*i.e.*, capping the bit-rate of certain users) that occur in the Verizon network, especially during periods of network congestion:



See, e.g., https://www.verizon.com/support/verizon-plan-unlimited-faqs/ (last visited Dec. 3, 2021).



https://www.verizon.com/support/verizon-plan-unlimited-faqs/ (last visited Dec. 8, 2021).

> On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans.

See, e.g., NM at 2; *see also* BSI at 3-4.

	5G Nationwide / 4G LTE: 5G Nationwide requires a 5G Nationwide compatible device. Devices manufactured before 2020 are not 5G Nationwide compatible. You will receive 4G LTE when 5G Nationwide isn't available. During times of congestion, your smartphone and mobile hotspot data may be temporarily slower than other traffic (only after 50 GB/mo of 5G Nationwide or 4G LTE data on Play More Unlimited 5G UW, Do More Unlimited 5G UW and Get More Unlimited 5G UW). Unlimited Mobile Hotspot available on Play More, Do More and Get More Unlimited 5G UW plans. Mobile Hotspot speeds reduced to 600 Kbps (only after 15 GB/mo 5G Nationwide/4G LTE on Play More and Do More Unlimited 5G UW plans and after 30 GB/mo on the Get More Unlimited 5G UW Plan). Using Mobile Hotspot counts toward your 50 GB monthly 5G Nationwide/4G LTE plan allocation. Domestic data roaming at 2G speeds; int'l data reduced to 2G speeds after 512 MB/day. If more than 50% of your talk, text or data usage in a 60-day period is in Canada or Mexico, use of those services in those countries may be removed or limited. 720p HD Video Streaming available on smartphones for Play More, Do More and Get More Unlimited 5G UW plans (must be turned on by customer in My Verizon online, the My Verizon App or by calling customer service); otherwise user will receive SD Video Streaming. SD (480p) Video Streaming on Start Unlimited. *See, e.g.*, IPI at 1.

CLAIM 4	'813 PATENT V. VERIZON
4[A]. The method of claim 1 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be under-utilized by said traffic profiles.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes performing the dynamically modifying step on a first device at a first end of the prioritization list if said network resource would be under-utilized by said traffic profiles. Lists are often processed from one end to the other. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

CLAIM 5	'813 PATENT V. VERIZON
5[A]. The method of claim 4 wherein said dynamically modifying comprises increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

CLAIM 6	'813 PATENT V. VERIZON
6[A]. The method of claim 5 wherein said increasing fully utilizes a remainder of a capacity of said network resource.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list wherein said increasing fully utilizes a remainder of a capacity of said network resource. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

CLAIM 7	'813 PATENT V. VERIZON
7[A]. The method of claim 1 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be over-utilized by said traffic profiles.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes performing the dynamically modifying step on a first device at a first end of the prioritization list if said network resource would be over-utilized by said traffic profiles. *See* 1[B] *and* https://community.verizon.com/t5/Verizon-Wireless-Services/Is-data-prioritization-supposed-to-make-your-dataplan-basically/td-p/995275 (last visited Nov. 1, 2021) ("If you've already used 22 GB on a particular line during your current billing cycle, ***and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers***, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment."). *See* 2[A] (citing evidence of modifying resource usage based on prioritization). Lists are often processed from one end to the other. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

CLAIM 8	'813 PATENT V. VERIZON
8[A]. The method of claim 7 wherein said dynamically modifying comprises decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

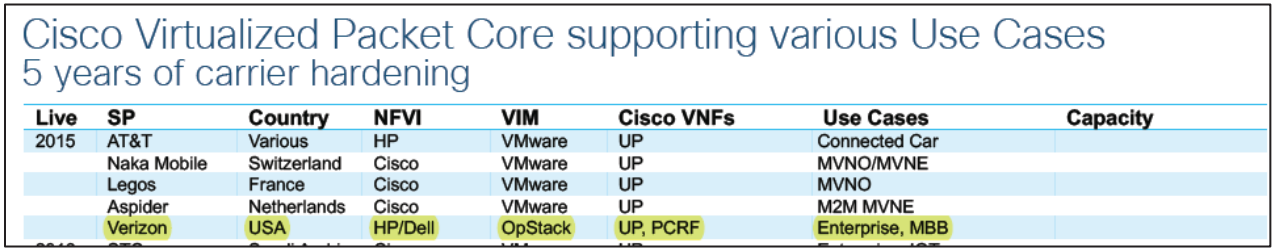
CLAIM 9	'813 PATENT V. VERIZON
9[A]. The method of claim 8 wherein said decreasing brings said traffic profiles into alignment with full utilization of a capacity of said network resource.	On information and belief, Verizon's implementation of dynamic allocation of network resources includes decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list wherein said decreasing brings said traffic profiles into alignment with full utilization of a capacity of said network resource. *See* 1[A] *and* NM at 2 (indicating that network management reduces data speeds for certain Verizon customers when a cell site begins experiencing high demand); 2[A] and 7[A], which are incorporated here by reference. Further discovery is necessary regarding the manner in which Verizon creates, implements, and uses its prioritization list, as well as the manner in which customer's bit-rates and/or data caps are adjusted during various network loading conditions.

CLAIM 10	'813 PATENT V. VERIZON
10[A]. An apparatus for dynamic allocation of network resources comprising:	Verizon provides network services to customers and, in doing so, uses an apparatus for dynamic allocation of network resources. Verizon's network services provided to customers rely on server hardware/software and other specialized hardware/software to implement dynamic allocation of network resources, such as that described by Claim 1. These hardware/software systems include, for example, OSS/BSS systems, base stations, RAN, 3G core, 4G core, and 5G core network elements. Exemplary hardware and software provided by Verizon's suppliers to support the dynamic allocation of network resources are detailed below. Further discovery is required to particularly identify each hardware/software component implemented by Nokia for dynamic allocation of network resources. On information and belief, Verizon uses hardware and/or software from third-parties to implement portions of its network services. *See, e.g.*, https://www.cisco.com/c/en/us/products/wireless/pgw-packet-data-network-gateway/index.html (last visited Dec. 16, 2021) (providing PCEF functionality and noting that "Verizon Wireless completes successful LTE data calls with Cisco equipment"); https://www.samsung.com/global/business/networks/insights/press-release/samsung-and-cisco-team-with-verizon-to-deliver-first-interconnected-multi-vendor-5g-trials/ (last visited Dec. 16, 2021) (disclosing that Verizon used Samsung and Cisco for its 5G network); https://www.ericsson.com/en/press-releases/2021/7/ericsson-and-verizon-ink-landmark-multi-year-$8.3-billion-5g-deal (last visited Dec. 16, 2021) (disclosing that Verizon uses Ericsson Cloud RAN and software for its 5G network). Verizon has implemented its virtualized packet core using Cisco software: > Samsung Electronics America, Inc. and Cisco, in partnership with Verizon, today announced the successful deployment of the first multi-vendor end-to-end 5G trial network in the field, which took place in Ann Arbor, a suburb of metropolitan Detroit, Michigan. > . . . > Earlier this year, Verizon announced plans for customer trials of 5G technology for home broadband service (Fixed Wireless Access). Five U.S. cities are scheduled to begin trials

in the second quarter of 2017, with pilot trials in a total of 11 markets expected by the middle of the year.

Each location offers a unique set of test parameters, including vendors, geographies, population densities and demographics, and the Ann Arbor location is the first to tackle a multi-vendor deployment of 5G. ***The solution includes a 5G virtualized packet core as part of the Cisco Ultra Services Platform with Cisco Advanced Services and Samsung virtual RAN solutions (vRAN)***, paired with Samsung's 5G Radio base stations and 5G home routers that will deliver broadband services to Verizon's trial customers.

https://newsroom.cisco.com/press-release-content?articleId=1844370 (last visited Jan. 24, 2022).



Cisco Virtualized Packet Core supporting various Use Cases
5 years of carrier hardening

Live	SP	Country	NFVI	VIM	Cisco VNFs	Use Cases	Capacity
2015	AT&T	Various	HP	VMware	UP	Connected Car	
	Naka Mobile	Switzerland	Cisco	VMware	UP	MVNO/MVNE	
	Legos	France	Cisco	VMware	UP	MVNO	
	Aspider	Netherlands	Cisco	VMware	UP	M2M MVNE	
	Verizon	USA	HP/Dell	OpStack	UP, PCRF	Enterprise, MBB	

Cisco Mobile Core Evolution (dated Feb. 6, 2020) at 8.

Verizon has relied on Cisco hardware and software in its network for many years:

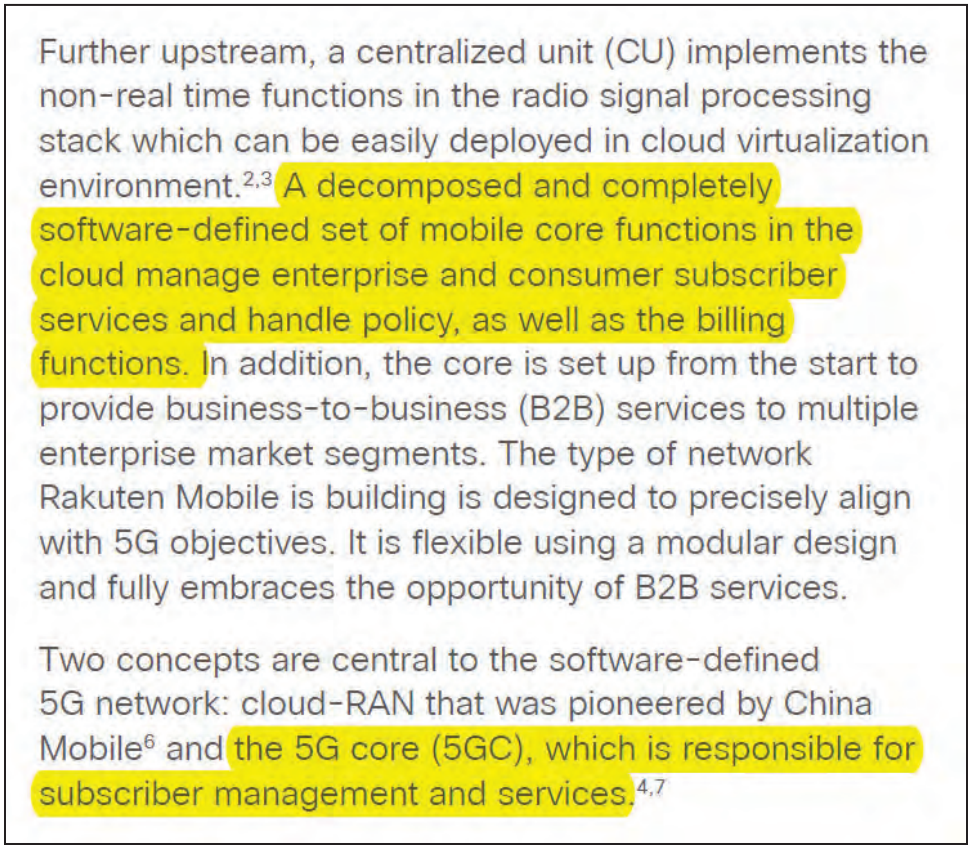
Cisco today announced today that it will demonstrate its mobility solution portfolio, using newly acquired technology from Starent Networks, with Verizon Wireless during the 2010 International Consumer Electronics Show (CES) in Las Vegas. With Starent, Cisco is a leader in LTE technology, which promises to deliver a rich user experience across multiple access networks through increased radio capacities and higher speed data networks.

. . .

Both Cisco and Starent Networks have long-standing relationships with Verizon Wireless. In February 2009, Verizon selected Starent Networks as one of its mobile core vendors for its 4G LTE network deployment and is using its multimedia core network equipment to enable next-generation multimedia applications.

https://www.verizon.com/about/news/vzw/2010/01/pr2010-01-07a (last visited Jan. 24, 2022).

Cisco's Ultra Cloud Core and Ultra Packet Core offerings are used to implement software-defined networks. These software-defined services permit for granular control of subscriber traffic.



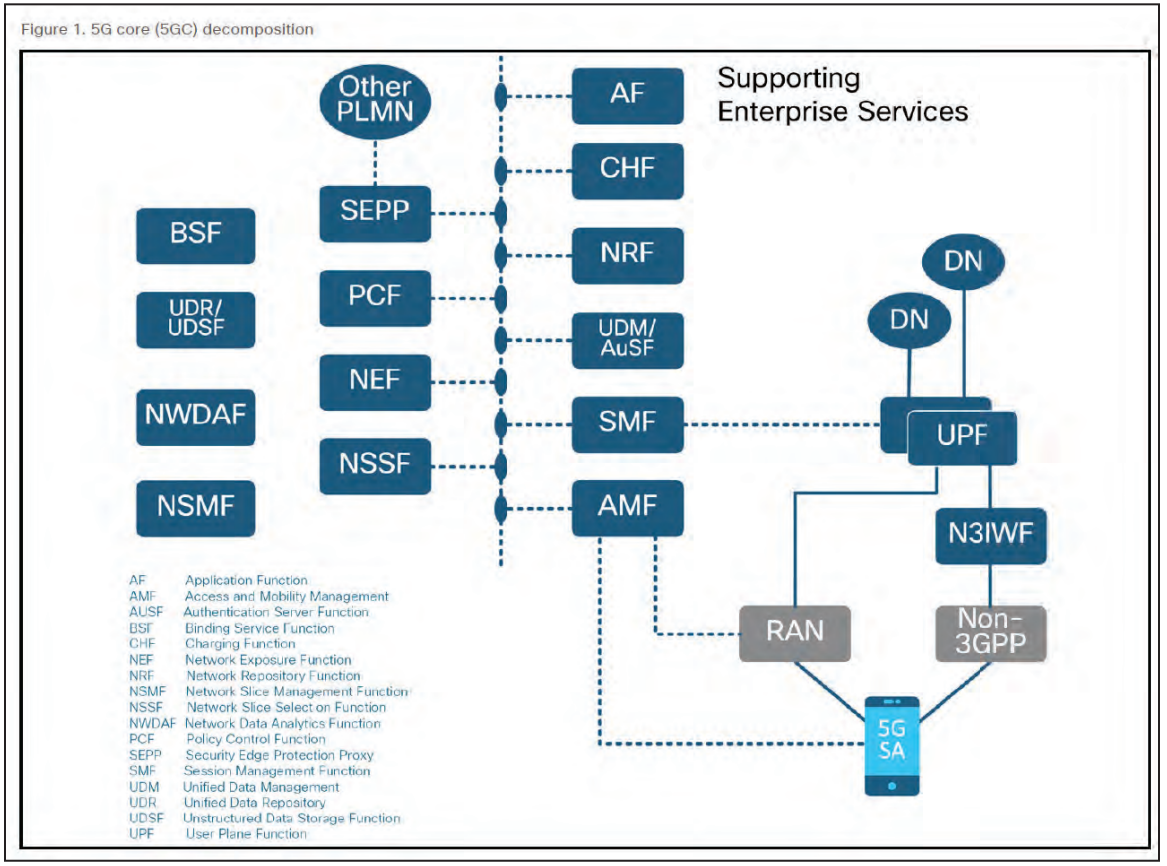
Further upstream, a centralized unit (CU) implements the non-real time functions in the radio signal processing stack which can be easily deployed in cloud virtualization environment.[2,3] A decomposed and completely software-defined set of mobile core functions in the cloud manage enterprise and consumer subscriber services and handle policy, as well as the billing functions. In addition, the core is set up from the start to provide business-to-business (B2B) services to multiple enterprise market segments. The type of network Rakuten Mobile is building is designed to precisely align with 5G objectives. It is flexible using a modular design and fully embraces the opportunity of B2B services.

Two concepts are central to the software-defined 5G network: cloud-RAN that was pioneered by China Mobile[6] and the 5G core (5GC), which is responsible for subscriber management and services.[4,7]

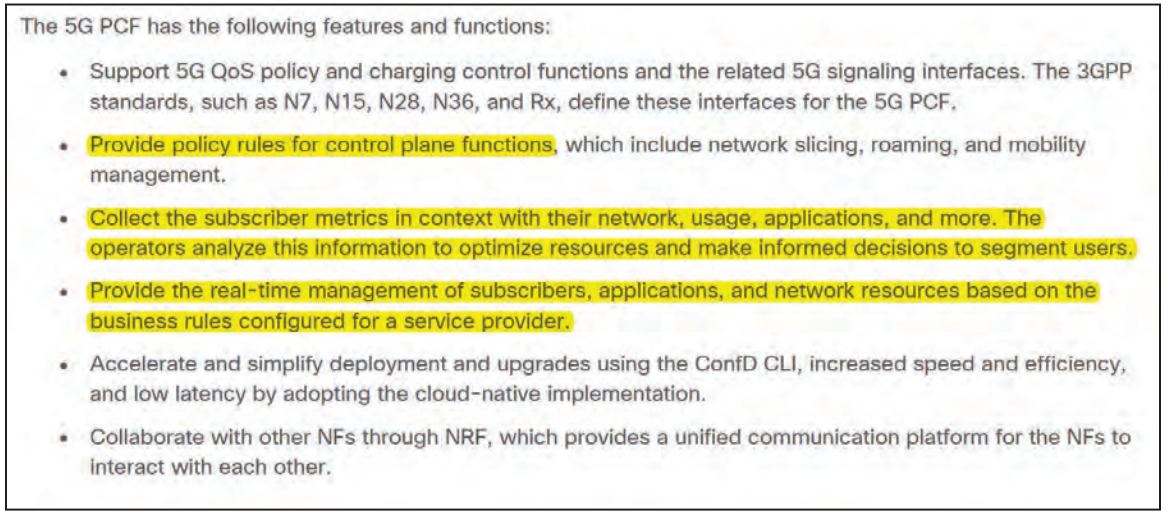
"Mapping Success: Evolving to software-defined mobile networks," Cisco Public White paper (2020) at 3. Cisco's "Ultra Cloud Core provides an intelligent service mesh that connects all services in the platform. This service mesh allows ***granular control of traffic flows*** within the Cisco Ultra Cloud Core ***based on message attributes or subscriber details***." Cisco Ultra Cloud Core, Datasheet (2021) at 4 (emphasis added).

The 5G core implemented by Cisco is illustrated below:

Figure 1. 5G core (5GC) decomposition



"Mapping Success: Evolving to software-defined mobile networks," Cisco Public White paper (2020) at 4. This 5G Core includes the PCF, or Policy Control Function. "Cisco PCF allows service providers to control and monetize their networks while enabling new business models with operational simplicity and faster time to market." Cisco 5G Policy Control Function (PCF), Datasheet (2021)) at 3. Cisco's PCF provides granular control of traffic based on "business rules configured for a service provider."



The 5G PCF has the following features and functions:

- Support 5G QoS policy and charging control functions and the related 5G signaling interfaces. The 3GPP standards, such as N7, N15, N28, N36, and Rx, define these interfaces for the 5G PCF.
- Provide policy rules for control plane functions, which include network slicing, roaming, and mobility management.
- Collect the subscriber metrics in context with their network, usage, applications, and more. The operators analyze this information to optimize resources and make informed decisions to segment users.
- Provide the real-time management of subscribers, applications, and network resources based on the business rules configured for a service provider.
- Accelerate and simplify deployment and upgrades using the ConfD CLI, increased speed and efficiency, and low latency by adopting the cloud-native implementation.
- Collaborate with other NFs through NRF, which provides a unified communication platform for the NFs to interact with each other.

Cisco 5G Policy Control Function (PCF), Datasheet (2021)) at 3.

Cisco also providers a virtualized policy and charging rules function (vPCRF) that similarly manages user traffic within a mobile network based on subscriber profile information and network congestion. The features and benefits of Cisco's vPCRF are detailed below:

Table 1. Features and benefits

Feature	Benefit
Powerful core rules engine	Gain a powerful rules engine that provides the framework for the policy rules as well as the APIs present on the system.
NFV orchestration	Use the CapEx and OpEx efficiencies of NFV. Rapidly deploy, configure, and scale vPCRF in an NFV environment for pursuit of vertical markets with vPCRF instances and network traffic demands.
Highly scalable and available	Support the scale required by large mobile networks while maintaining low latency at high transaction rates. Geographic high availability provides for geographical redundancy and disaster recovery configurations.
Web- and API-based service definition	Rapidly define new service plans using customizable policy building blocks that support bandwidth tiers, monthly fair use limits, breach rules, and more.
PCEF controls	Correlate, control, and coordinate policies across multiple policy enforcement points—for example, a Packet Data Network Gateway (PDN GW) and a Deep Packet Inspection (DPI) device for a subscriber's session.
Quality of Service (QoS) control	Authorize and control the subscriber's QoS across both default and dedicated bearers.

Cisco Virtualized Policy and Charging Rules Function (vPCRF), Data sheet (2021) at 3.

Feature	Benefit
Usage-based policies	Control and monetize bandwidth using internal quota or through integration with an external charging system.
Application detection control	Add application-level control to existing subscriber, time, location, and usage parameters.
Flexible subscriber data schema	Fit your data, not the other way around.
Simplified provisioning	SOAP/REST web services API support simplifies integration to OSS/BSS applications. An onboard subscriber management GUI provides a single interface for viewing data from multiple repositories.

Cisco Virtualized Policy and Charging Rules Function (vPCRF), Data sheet (2021) at 4.

	Cisco also supplies Packet Data Network Gateway (P-GW) and Integrated System Architecture Gateway (SAE-GW) systems that include Policy and Charging Enforcement Function (PCEF) functionality. On information and belief, Verizon implements these systems using Cisco ASR5000 Series hardware and software. https://www.cisco.com/c/en/us/products/wireless/pgw-packet-data-network-gateway/index.html ("Acts as the Policy and Charging Enforcement Function (PCEF)"); *id.* ("Verizon Wireless completes successful LTE data calls with Cisco equipment"). On information and belief, Verizon's network uses Cisco software and/or hardware to implement policy control functions similar to those described above for Cisco's PCF, vPCRF, PCRF, and PCEF. *See* Cisco 5G Policy Control Function (PCF), Datasheet (2021)) at 5 (detailing platform support); Cisco Virtualized Policy and Charging Rules Function (vPCRF), Data sheet (2021) at 5 (detailing platform support); Cisco Could Services Stack for Mobility (describing Cisco's "could-based mobile packet core solution"). Verizon has also implemented a virtualized packet core using Ericsson hardware and software: > In a proof-of-concept trial in a live network environment, Verizon and Ericsson have introduced cloud native, container based technology on the core of Verizon's active network. ***This trial, the first container- based wireless EPC (Evolved Packet Core) technology deployment in a live network in the world, introduces a much more efficient way to deliver operational applications that run the network. It is a solution that will increase agility and enable deployment at scale for new services in 4G and 5G.*** > . . . > The proof-of-concept trial took place in Hillsboro, Oregon and the deployment was conducted on Verizon's commercial network, using Ericsson Packet Core Controller deployed as a cloud-native and microservice-based Mobility Management Entity (MME) in an existing pool. The software used leverages docker images and helm charts, with expected updates on the software from Ericsson every two weeks. https://www.verizon.com/about/news/verizon-and-ericsson-introduce-cloud-native-technology (last visited Jan. 24, 2022). > Ericsson's Cloud Core solution is a natural evolution of EPC systems for 5G. By comprising service-based architecture, combined with automation capabilities and

network slicing technology, operational costs will be reduced and operators will be able to introduce agile and adaptive ways of working. We offer one core system for all accesses and services with a 5G dual mode operations core for a simplified evolution, even if your starting point is not from a complete Ericsson 4G core.

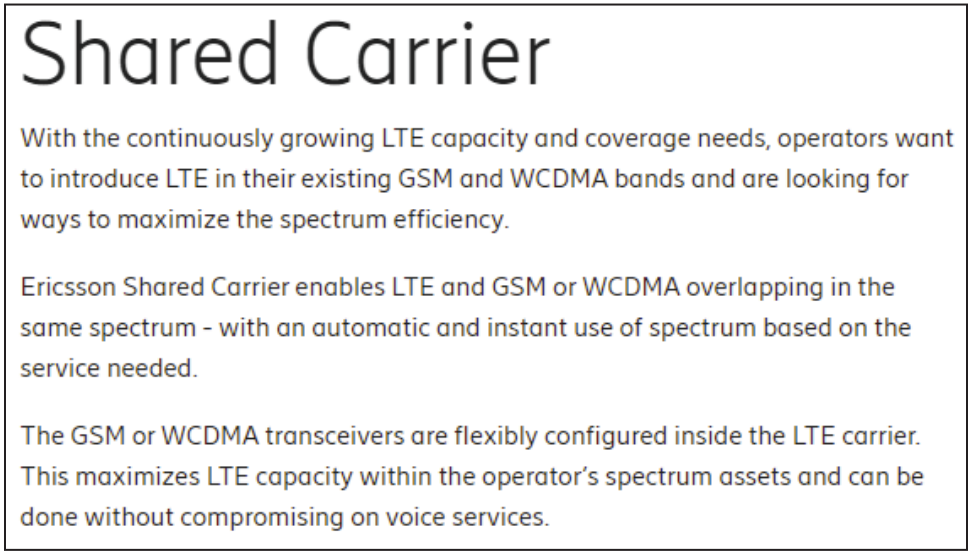
Today Ericsson has 100+ commercial vEPC customers. Together with 10+ live networks and hands-on experience from 5G trials with leading operators including BT, Wind Tre, Verizon and Swisscom, we have end-to-end system solutions that have been defined and extensively tested to secure an early and smooth time to market. Our implementation and delivery of Ericsson Radio Access and core solutions at Swisscom, including virtual EPC, has reduced the operator's opex by 65% and improved software quality. We were also recently named a market leader of pre-tested mobile core solutions according to GlobalData.

https://www.ericsson.com/en/blog/2018/8/to-be-first-in-5g-first-get-to-the-core-network (last visited Jan. 24, 2022).

Part of Ericsson's Radio System Software includes dynamic (demand-driven) spectrum sharing, which allows rapid allocation of spectrum depending on the needs of the base station resource at a given time.

. . .

	Ericsson pioneered the creation of an ecosystem around the 3GPP-defined standards for Dynamic Spectrum Sharing. While delivering all the ecosystem's benefits, Ericsson Spectrum Sharing takes the technology even further. The unique Ericsson Spectrum Sharing scheduler enables rapid (per-millisecond) demand-driven spectrum allocation between 4G LTE and 5G NR. This maximizes spectrum efficiency and enables new low-latency use cases. Ericsson Spectrum Sharing can be activated remotely through a software update in more than five million Ericsson Radio Systems already in service worldwide. Ericsson Spectrum Sharing has full eco-system support. https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/ericsson-spectrum-sharing (last visited Jan. 24, 2022). Ericsson's shared carrier services provide similar on-demand allocation of network spectrum.



Shared Carrier

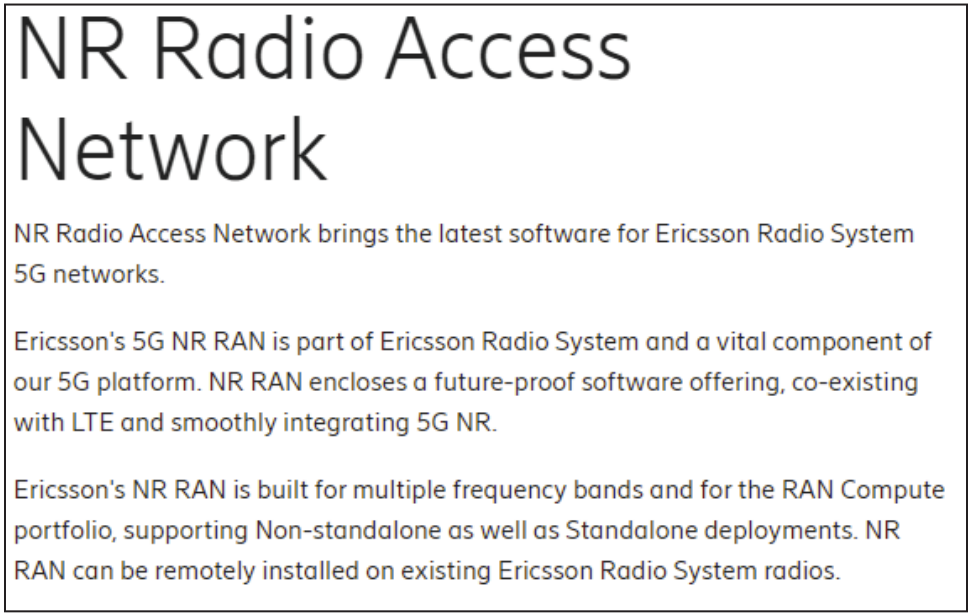
With the continuously growing LTE capacity and coverage needs, operators want to introduce LTE in their existing GSM and WCDMA bands and are looking for ways to maximize the spectrum efficiency.

Ericsson Shared Carrier enables LTE and GSM or WCDMA overlapping in the same spectrum - with an automatic and instant use of spectrum based on the service needed.

The GSM or WCDMA transceivers are flexibly configured inside the LTE carrier. This maximizes LTE capacity within the operator's spectrum assets and can be done without compromising on voice services.

https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-solutions/shared-carrier (last visited Jan. 24, 2022).

Ericsson's radio hardware includes and is controlled in part by Ericsson software.



https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/nr-radio-access-network (last visited Jan. 24, 2022).

Ericsson's 5G software plugins "intelligently route data and users based on application requirements and device capabilities."

5G Plug-Ins include:

- Massive MIMO and Multi-user MIMO: Combines MIMO with beamforming on advanced antennas to improve the user-experience, capacity, and coverage of the mobile network
- Intelligent Connectivity: Increases the combined data throughput and coverage of 5G by enabling the network to intelligently route data and users based on application requirements and device capabilities
- RAN Virtualization: Improves network efficiency and performance by enabling Virtual Network Functions (VNF) to be centralized on a common 4G / 5G platform
- Latency Reduction: Reduces time to content while enabling real-time communications

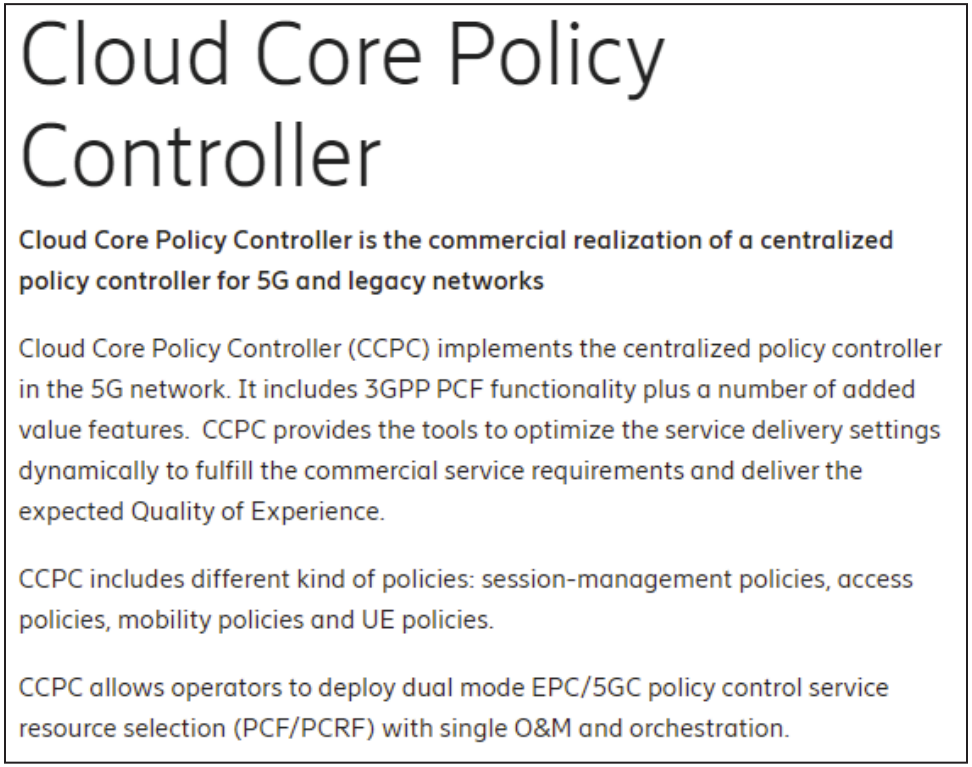
https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/5g-plug-ins (last visited Jan. 24, 2022).

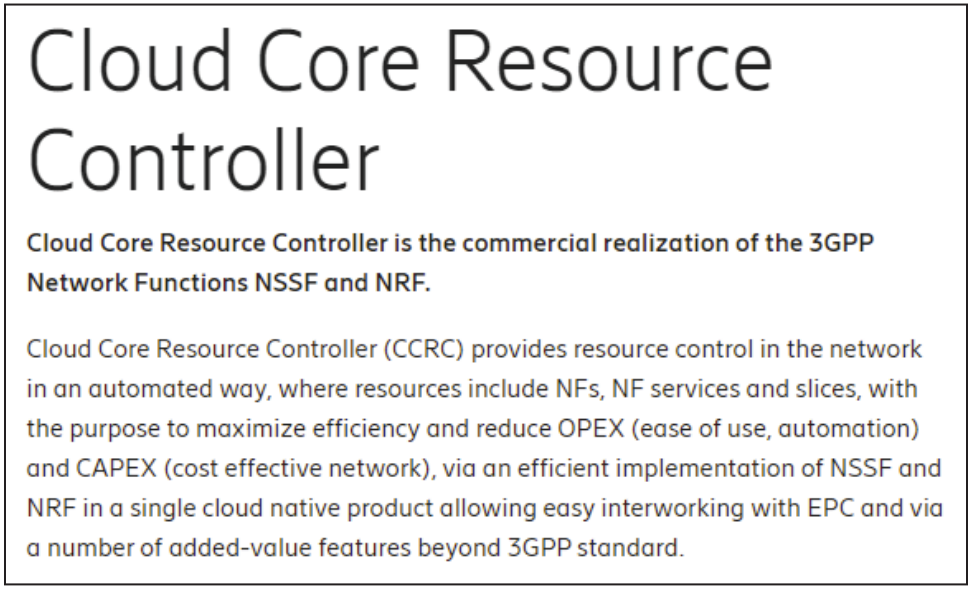
Ericsson's Orchestration capabilities provide a "dynamic approach to managing the service and the resource upon which they depend."

Use Your Resources Efficiently to Provide a Differentiated Experience

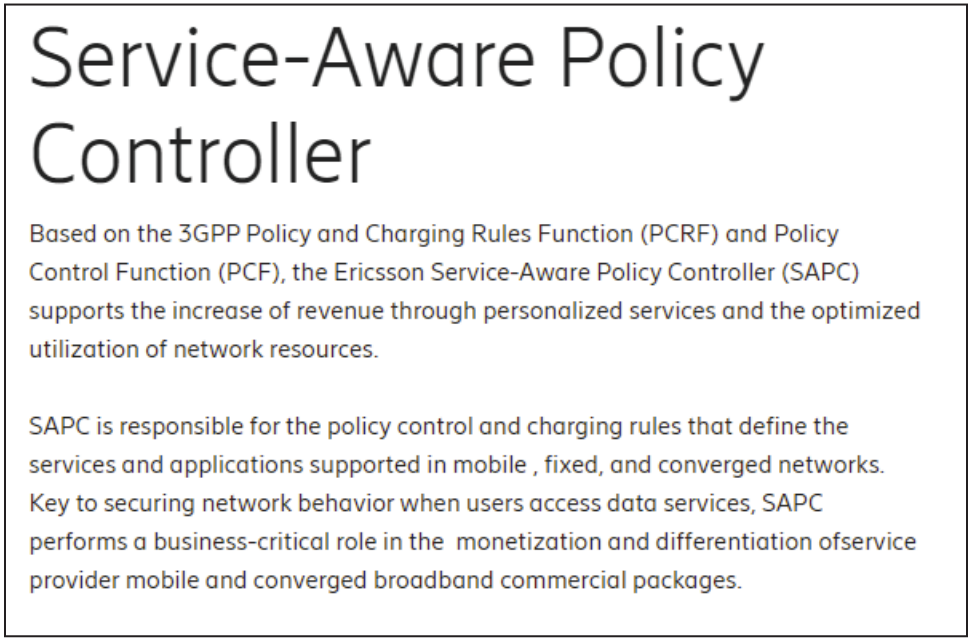
In today's information-driven marketplace, gaining a competitive edge takes a new level of agility that can only be reached through a more dynamic approach to managing the service and the resource upon which they depend. Choose Ericsson's Orchestration solutions for unsurpassed flexibility, automation, usability and openness.

https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-solutions/5g-ran-slicing-solution/automated-network-operations/orchestration (last visited Jan. 24, 2022).

	Ericsson's Cloud Core technologies include multiple policy-related offerings, such as the Cloud Core Policy Controller, Cloud Core Resource Controller, and Service-Aware Policy Controller.  https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/cloud-core-policy-controller (last visited Jan. 24, 2022).

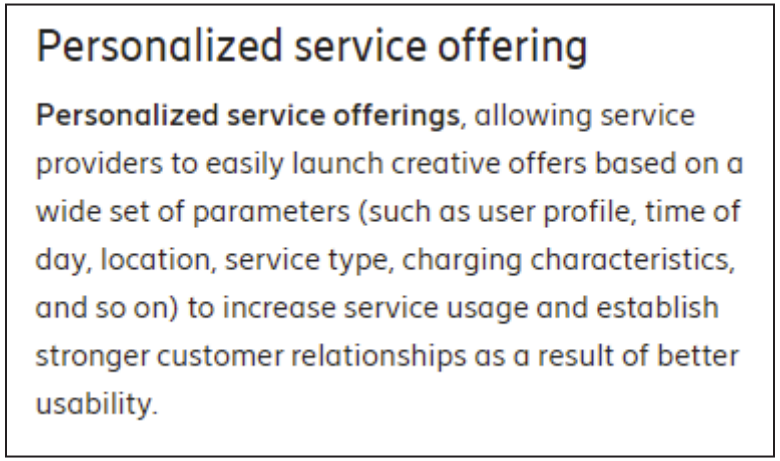


https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/cloud-core-resource-controller (last visited Jan. 24, 2022).



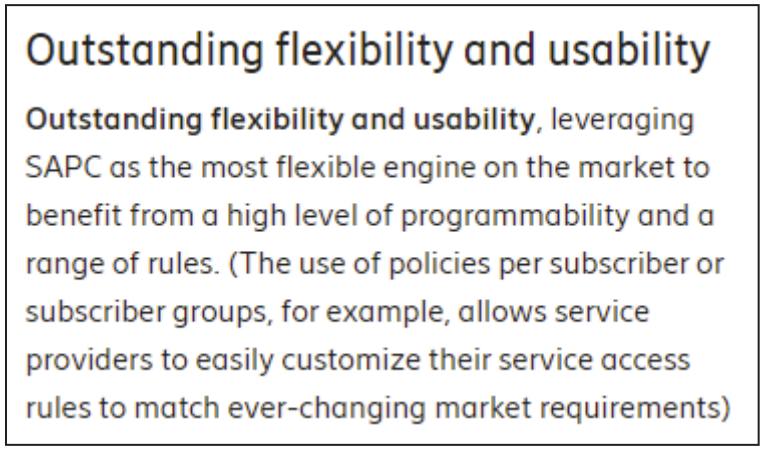
https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller (last visited Jan. 24, 2022).

The SAPC provides personalized service to consumers based on their service profile, billing profile, and/or billing history.

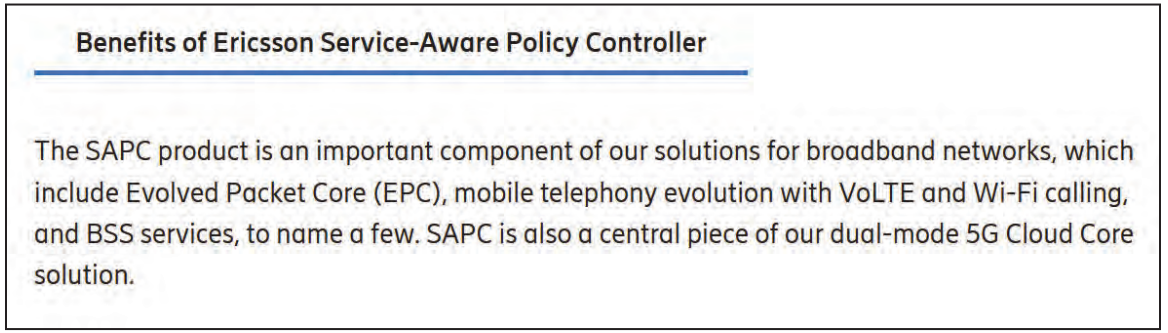


https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller (last visited Jan. 24, 2022).

The SAPC also supports granular rules for controlling access to and use of network resources.



https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller (last visited Jan. 24, 2022). The SAPC components is an important part of Ericsson's broadband network solution.

	 https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller (last visited Jan. 24, 2022). On information and belief, Verizon has used Camiant MPE to implement the PCRF on its LTE network. https://www.verizon.com/about/news/vzw/2010/03/pr2010-03-23q (last visited Dec. 16, 2021) ("Verizon Wireless has selected Camiant's Multimedia Policy Engine (MPE) as the Policy and Charging Rules Function (PCRF) for Verizon Wireless' previously announced nationwide deployment of a 4G Long Term Evolution (LTE) network."). Tekelec acquired Camiant in May 2010. https://www.vanillaplus.com/2010/05/06/1290-tekelec-pays-us165m-to-buy-camiant-and-blueslice/ (last visited Dec. 16, 2021). On information and belief, Verizon the continued to use Tekelec software after the acquisition. https://www.lightreading.com/ethernet-ip/verizon-manages-its-own-data-destiny/d/d-id/697874 (last visited Dec. 16, 2021). On information and belief, Verizon continued to use Oracle Policy Controller to implement the PCRF on its LTE network after Oracle acquired Tekelec in 2013, including Tekelec's policy control and subscriber data management solutions. https://www.oracle.com/corporate/pressrelease/oracle-buys-tekelec-032513.html (last visited Dec. 16, 2021).
10[B] a network interface configured to receive a service profile for each of a plurality of devices sharing a network resource and to receive a billing profile for	*See* the discussion and evidence recited in limitation 1[B] and 1[C], which are incorporated here by reference. On information and belief, the Verizon network includes a network management server and/or a performance/monitoring server that receives a service profile and a billing profile for each of the customer's that are accessing a particular cell site. These servers are responsible for allocating a defined bit-rate for each of the customers that are then currently accessing the shared network resource (e.g.,

each of said plurality of devices; and	base station or cell tower or backhaul network). These servers contain a network interface that allows those devices to receive a service profile for each of a plurality of devices sharing a network resource and to receive a billing profile for each of said plurality of devices. The specific identity of the network interface(s) that receive the service profile and billing profile will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.
10[C] a processor connected to said network interface and configured to generate a prioritization list defining an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;	The server(s) identified in limitation 10[B] include a processor and are configured to generate a prioritization list consistent with the method described in limitation 1[D]. The specific identity of the server/processor that generates the prioritization list will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.
10[D] said processor further configured to repeat:	Verizon's implementation of dynamic allocation of network resources includes repeating steps 10[E], 10[F], and 10[G] below. *See* limitation 1[E], which is incorporated here. The specific identity of the server(s)/processor(s) that repeatedly performs the subsequent claimed steps will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.
10[E] receiving traffic profiles over said network resource for said plurality of devices;	*See* Claim 1[F], which is incorporated here. On information and belief, the Verizon network includes a gateway or aggregating unit that connects to the base stations or cell towers through a backhaul network. The traffic profiles that exist currently on the base station or cell tower or backhaul network are received by the gateway or aggregating unit, which provides that information to the server(s) managing the network resource. The specific identity of the server that receives the traffic profiles will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.

10[F] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	*See* Claim 1[G], which is incorporated here. On information and belief, the Verizon network includes servers that manage the network resource according to the service profile and billing profile when the network resource is fully utilized. The specific identity of the server that performs the management of the network resource will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.
10[G] selecting at least one of said devices based on said prioritization list and dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles;	*See* Claim 1[H] and 1[I], which are incorporated here by reference. On information and belief, the Verizon network includes server(s) that select a device from the prioritization list and modifies at least one of the service profile and/or billing profile of that selected device when the Verizon network becomes heavily loaded (or congested), and also when the Verizon network reverts from being heavily loaded (or congested) to being lightly loaded. The specific identity of the server the selecting and dynamic modifying profiles will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claim 1.
10[H] until said plurality of devices no longer continue to share said network resource; and	*See* Claim 1[J], which is incorporated here. On information and belief, the Verizon network servers identified in the preceding steps (10[E]-[G]) will manage the network resource until the device(s) no longer share the network resource
10[I] said processor further configured, when said plurality of devices are no longer sharing said	*See* Claim 1[K], which is incorporated here. On information and belief, the Verizon network servers identified in the preceding steps (10[E]-[G]) will clear the prioritization list when the device(s) no longer shares the network resource

network resource, to clear said prioritization list.	

CLAIM 11	'813 PATENT V. VERIZON
11[A]. The apparatus of claim 10 wherein said dynamically modifying comprises increasing or reducing an overall bit-rate cap or data volume cap in a service profile for at least one of said devices.	*See* Claim 2[A] and 10[G], which are incorporated here.

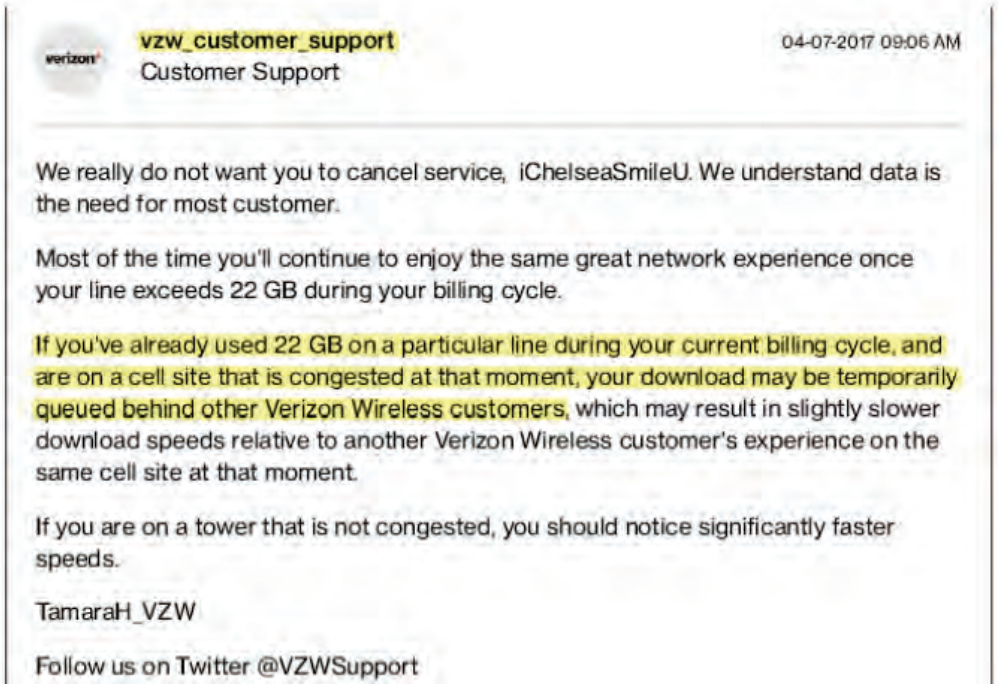
CLAIM 13	'813 PATENT V. VERIZON
13[A]. The apparatus of claim 10 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be over-utilized by said traffic profiles.	*See* Claim 7[A], which is incorporated here.

CLAIM 14	'813 PATENT V. VERIZON
14[A]. The apparatus of claim 10 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be under-utilized by said traffic profiles.	*See* Claim 4[A], which is incorporated here.

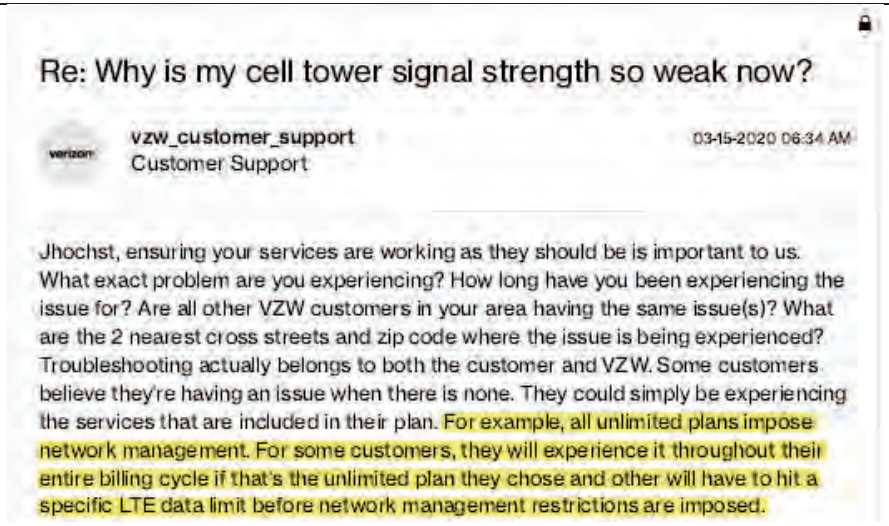
CLAIM 15	'813 PATENT V. VERIZON
15[A]. The apparatus of claim 10 wherein said apparatus is incorporated into a policy server that connects to said devices via a public land mobile network infrastructure.	On information and belief, Verizon's network includes a policy server (e.g., PCRF, PCF, Control Plane Function) that includes the dynamic resource allocation apparatus detailed in Claim 10. *See* 10[A] (detailing policy servers provided by Cisco, Ericsson, and Oracle). On information and belief, the policy server connects to cellular devices through a public land mobile network infrastructure, including a backhaul network used to connect the base stations or cell towers to the Verizon core network, a 2G network, a 3G network, a 4G network, and/or a 5G network. The specific identity of the policy server and its associated network connections to which and from which it receives data will be provided once discovery is completed on the Verizon internal network architecture.

CLAIM 17	'813 PATENT V. VERIZON
17[A]. The apparatus of claim 10 wherein said network interface is configured to connect to a policy server and a billing server that are each connectable to said devices via a public land mobile network infrastructure.	The specific network connections between the policy server and the billing server are currently unknown. Thus, discovery of Verizon's internal network architecture is necessary to assess infringement of this claim.

CLAIM 18	'813 PATENT V. VERIZON
18[A]. A computer-implemented method for dynamic allocation of network resources comprising:	Verizon provides network services to customers and, in doing so, implements a method for dynamic allocation of network resources via software and hardware. *See* Claim 1[A], which is incorporated herein.
18[B] grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;	Verizon's implementation of dynamic allocation of network resources includes performing the step of grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource. Implementing Verizon's network services requires hardware or software components within Verizon's cellular network (a "computing system") to group Verizon UEs share a cellular network resource, such as a cell site, base station, cell tower, or backhaul network. *See* https://community.verizon.com/t5/Verizon-Wireless-Services/Is-data-prioritization-supposed-to-make-your-dataplan-basically/td-p/995275 (last visited Nov. 1, 2021); https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021). Verizon indicates it adjusts the data rates of its users using a prioritization scheme that "temporarily" queues certain customers behind others during congestion, but maintains faster data rates on cell sites that are not congested:

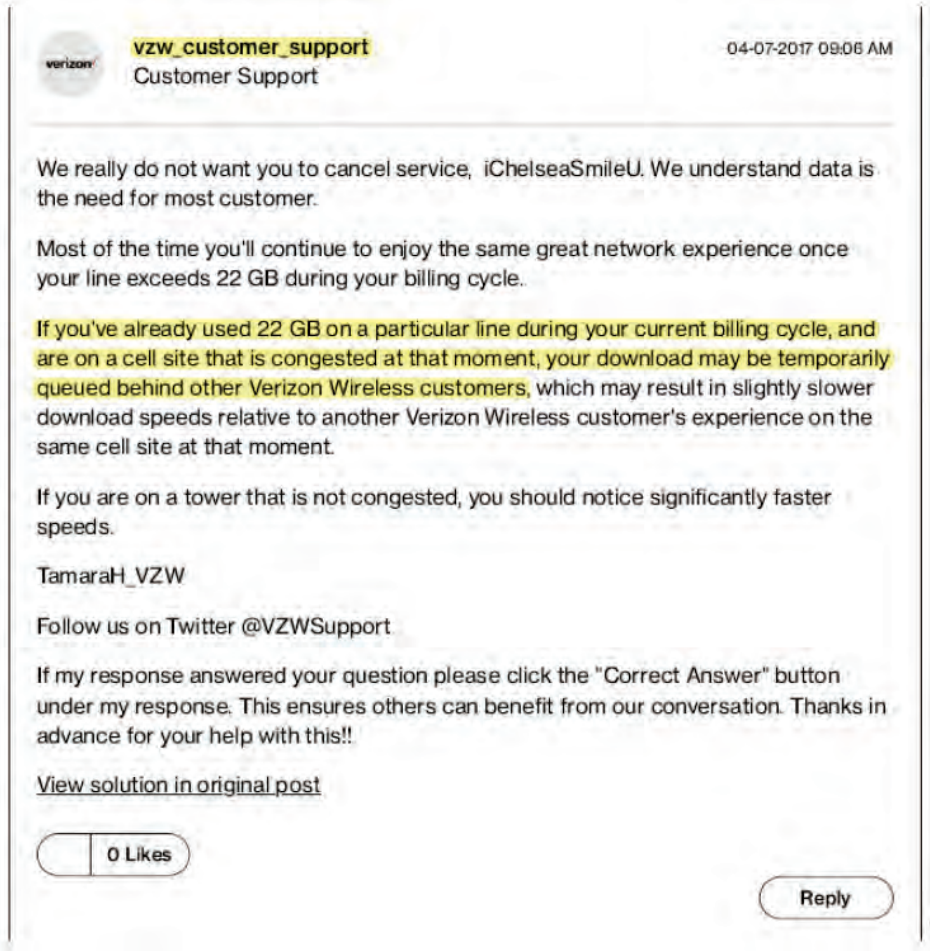
	 vzw_customer_support Customer Support 04-07-2017 09:06 AM We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer. Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle. If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment. If you are on a tower that is not congested, you should notice significantly faster speeds. TamaraH_VZW Follow us on Twitter @VZWSupport https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021).
18[C] receiving a service profile for each of the plurality of devices sharing the network resource;	Verizon's implementation of dynamic allocation of network resources includes performing the step of receiving a service profile for each of the plurality of devices sharing the network resource. *See* limitation 1[B], which is incorporated here. Implementing Verizon's network services calls for receiving a service profile (*e.g.*, a directive to regulate data traffic, such as a directive to supply certain data speeds and/or data caps according to Verizon phone plan) for each of the plurality of devices sharing the network resource, as the following example illustrates:

	On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4.Additional examples and discussion are found in the discussion related to limitation 1[B].
18[D] receiving a billing profile for each of said plurality of devices;	Verizon's implementation of dynamic allocation of network resources includes performing the step of receiving a billing profile for each of said plurality of devices. *See* limitation 1[C], which is incorporated here. Implementing Verizon's network services requires receiving a billing profile, *e.g.*, one or more components of information maintained by Verizon regarding a billing parameter that regulates rating or charging or both of traffic to and from a customer's cellular service/data plan relating to the cost of services provided, including rate schedules, overage charges, and billing history for each of said plurality of devices. These billing profiles factor into the prioritization scheme, as the following example illustrates:

	 *See* https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021). Additional examples and discussion are found in the discussion related to limitation 1[C].
18[E] generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices;	Verizon's implementation of dynamic allocation of network resources includes performing the step of generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices. *See* limitation 1[D], which is incorporated by reference here. Implementing Verizon's network services includes generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices. Certain devices will be prioritized before other devices, based on, in part, the billing history and profile of that device, including specific plan, features, and/or previously paid data usage: *See* Claim 1[D] (explaining that the specific Verizon plan and a customer's consumption of their high-speed data within a billing cycle factors into the prioritization scheme)
18[F] repeating, by the computing system:	Verizon's implementation of dynamic allocation of network resources includes repeating, by the computing system, steps 18[G]-18[J] below.

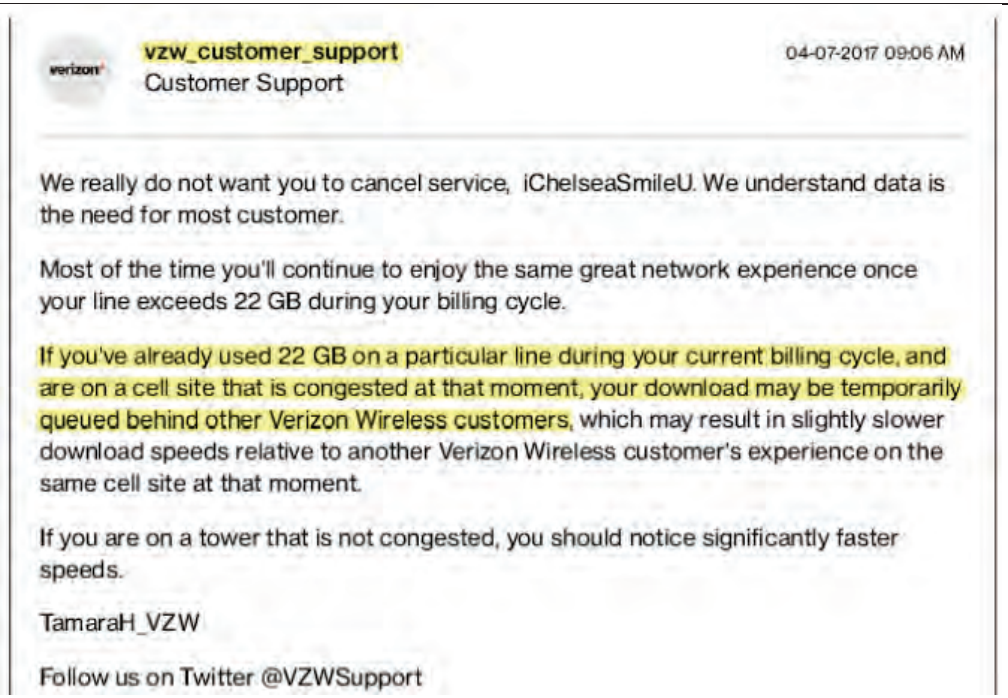
	See limitation 1[E], which is incorporated here.
18[G] determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;	Verizon's implementation of dynamic allocation of network resources includes performing the step of determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices *See* limitation 1[F], which is incorporated here. Prioritization occurs "[d]uring times of congestion." IPI at 1. The traffic profile of each device is comprised of the data transmission and data reception activity for a given device and includes the specific data transmission request from the user (*e.g.*, a request for content that consumes five megabits per second). The traffic profile for a given device is determined and received by the Verizon network as such data transmission and data reception requests are circulated through the Verizon network. Prioritization therefore necessarily requires Verizon's cellular network to first determine whether there is any traffic over the network resource, such as one or more cell phones transmitting data through a cell site or base station or other shared network resource between the mobile device and core network. Verizon's cellular network will base its prioritization decisions on, in part, the current traffic congestion of the network resource: You must be using an approved, network compatible device and be within the Verizon coverage area to access the Verizon network. Whether you experience these speeds depends on many factors, including among others, the type of device, the programs running on the device, your location, and how many other customers are attempting to use the same spectrum resources (including both mobile broadband internet access and other non-broadband internet access services that share the network, such as Private Network Traffic Management, HD Voice, Push to Talk Plus, and MDM). For information on our network and testing of the network, go to https://www.verizon.com/featured/our-network/ (/featured/our-network/) *See, e.g.*, BSI at 3. Additional examples and discussion are found in the discussion related to limitation 1[F]
18[H] managing said network resource according to said service profile and said billing	Verizon's implementation of dynamic allocation of network resources includes performing the step of managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles. *See* Claim 1[G], which is incorporated here.

profile if said network resource is fully utilized by said traffic profiles; and,	Implementing Verizon's Broadband Internet Access Services manages the shared network resources according to the service and billing profile of the device selected according to limitation 18[I]. For example, the shared network resource will deliver data according to the service profile and billing profile—which depends, in part, on the customer's priority and whether the resource is congested: You must be using an approved, network compatible device and be within the Verizon coverage area to access the Verizon network. Whether you experience these speeds depends on many factors, including among others, the type of device, the programs running on the device, your location, and how many other customers are attempting to use the same spectrum resources (including both mobile broadband internet access and other non-broadband internet access services that share the network, such as Private Network Traffic Management, HD Voice, Push to Talk Plus, and MDM). For information on our network and testing of the network, go to https://www.verizon.com/featured/our-network/ (/featured/our-network/) *See, e.g.*, BSI at 3. Additional examples and discussion are found in the discussion related to limitation 1[G]
18[I] selecting at least one of said devices based on said prioritization list; and	Verizon's implementation of dynamic allocation of network resources includes performing the step of selecting at least one of said devices based on said prioritization list. *See* limitation 1[H], which incorporated here. Implementing Verizon's Broadband Internet Access Services includes selecting at least one of the devices for prioritization. *See, e.g.*, NM at 2 (explaining that Verizon "may prioritize your 5G Nationwide and 4G LTE data behind other traffic.").
18[J] dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles,	Verizon's implementation of dynamic allocation of network resources includes performing the step of dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource. *See* the discussion and evidence referenced in limitation 1[I], which is incorporated here. Implementing Verizon's Broadband Internet Access Services includes dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles

wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource;	or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource. For example, Verizon will prioritize certain user's data to a lower bit rate when a network resource is congested:  vzw_customer_support Customer Support 04-07-2017 09:06 AM We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer. Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle. If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment. If you are on a tower that is not congested, you should notice significantly faster speeds. TamaraH_VZW Follow us on Twitter @VZWSupport If my response answered your question please click the "Correct Answer" button under my response. This ensures others can benefit from our conversation. Thanks in advance for your help with this!! View solution in original post 0 Likes Reply

	VZ Community at 3-4. Additional examples and discussion are found in the discussion related to limitation 1[I]
18[K] until said plurality of devices no longer continue to share said network resource; and	Verizon's implementation of dynamic allocation of network resources includes repeating the steps 18[G]-1[J] until said plurality of devices no longer continue to share said network resource. *See* limitation 1[J] Implementing Verizon's Broadband Internet Access Services includes prioritizing the data traffic by repeating steps 18[G]-18[J] until said plurality of devices no longer continue to share the network resource. Verizon explains that prioritization is temporarily enforced while a network resource experiences congestion and does not occur when the customer is not on a congested resource. VZ Community at 3-4. Additional examples and discussion are found in the discussion related to limitation 1[J]. *See also* 1[I].
18[L] when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	Verizon's implementation of dynamic allocation of network resources includes performing the step of, when said plurality of devices are no longer sharing said network resource, clearing said prioritization list. *See* limitation 1[K] Implementing Verizon's Broadband Internet Access Services includes clearing the prioritization list when the plurality of devices are no longer sharing the network resource (i.e., the prioritization list is generated anew when the network resource becomes congested). *See, e.g.*, NM at 2 ("Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal."). Additional examples and discussion are found in the discussion related to limitation 1[K].

CLAIM 19	'813 PATENT V. VERIZON
19[A]. The method of claim 18, wherein the network resource is a cellular base station.	Verizon identifies a "cell site," which includes a base station or cell tower, as a shared network resource. On certain plans, we may prioritize your 5G Nationwide and 4G LTE data behind other traffic. If the cell site you are connected to begins experiencing high demand during the duration of your session, your 5G Nationwide and 4G LTE data speeds may be slower than the other traffic's. Once the demand on the site lessens, or if you connect to a different site not experiencing high demand, your speed will return to normal. Any such network management practices will be disclosed in the descriptions of impacted plans. *See, e.g.*, NM at 2; *see also* BSI at 3-4. Other materials provided by Verizon also explain the dynamic allocation of service/data levels that occurs when a customer accesses a congested base station (or cell tower) in situations where it has exceeded its data cap during a monthly billing cycle:



vzw_customer_support
Customer Support

04-07-2017 09:06 AM

We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer.

Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle.

If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment.

If you are on a tower that is not congested, you should notice significantly faster speeds.

TamaraH_VZW

Follow us on Twitter @VZWSupport

VZ Community at 3-4.

CLAIM 20	'813 PATENT V. VERIZON
20[A]. The method of claim 18, wherein the network resource is a back-haul link.	The base stations or cell towers connect to the Verizon core network through a backhaul link. Like the base stations, the backhaul link is a network resource that is shared by the cellular devices that are accessing the Verizon network. Like the base station or cell tower, the capability of the backhaul network to carry data traffic has physical limits. On information and belief, Verizon monitors the backhaul link and will dynamically modify the load on the backhaul link in situations where the traffic demand exceeds capacity.

CLAIM 21	'813 PATENT V. VERIZON
21[A]. The method of claim 18, wherein the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type.	Verizon's network services implementation considers whether the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type. **Does Verizon Wireless take any steps to manage the flow of data on the network used for Broadband Internet Access Services?** Verizon Wireless strives to provide customers the best experience when using our network, which is a shared resource among tens of millions of customers. Verizon Wireless has used sound engineering principles in the design and operation of its broadband network to ensure a good user experience for all customers. An individual user's experience will vary depending upon many factors, including the plan they select, the network (5G Ultra Wideband, 5G Nationwide, 4G LTE, or 3G Ev-DO) the customer is using, and the device in use. See, e.g., BSI at 3; see also NM at 2; *see also* Claim 1[A], explaining prioritization occurs "during congestion").

CLAIM 23	'813 PATENT V. VERIZON
23[A]. The method of claim 18, wherein the dynamic modification further includes modifying a restriction on one or more content types.	Verizon's network services implementation of dynamic resource allocation allows for the dynamic modification to modify a restriction on one or more content types. For example, the prioritization may reduce the typical speed of video streams (which stream at 480p, 720p or 1080p depending on the Verizon plan): **Does Verizon Wireless take any steps to manage the flow of data on the network used for Broadband Internet Access Services?** Verizon Wireless strives to provide customers the best experience when using our network, which is a shared resource among tens of millions of customers. Verizon Wireless has used sound engineering principles in the design and operation of its broadband network to ensure a good user experience for all customers. An individual user's experience will vary depending upon many factors, including the plan they select, the network (5G Ultra Wideband, 5G Nationwide, 4G LTE, or 3G Ev-DO) the customer is using, and the device in use. Verizon Wireless has implemented optimization technologies across its 5G Nationwide and 4G LTE networks to transmit data files in a more efficient manner to allow available network capacity to benefit the greatest number of users. These techniques include video caching and sizing video files more appropriately for mobile devices. The optimization process is agnostic as to the content itself and to the website that provides it. While Verizon Wireless invests much effort to avoid changing text, image, and video files in the optimization process and while any change to the file is likely to be indiscernible, the optimization process may minimally impact the appearance of the file as displayed on a customer's device. In addition, in order to optimize customers' video viewing experiences over our 5G Nationwide and 4G LTE networks on their devices while ensuring a high quality experience for other users of the network, Verizon seeks to transmit video downloads or streams to smartphones at 480p or 720p, depending on the plan, and to devices with larger screens at 1080p, unless a different video resolution is disclosed in the description of a particular plan. This practice does not make any distinction based on the content of the video or the source website. To achieve this optimization, Verizon limits the throughput speeds of such video downloads or streams over our 5G Nationwide and 4G LTE networks (which may be below the 9-56 Mbps 5G Nationwide and 4G LTE download speeds typically provided). This practice results in the video provider's content server sending the appropriate resolution video file for that speed, if available. BSI at 3.

CLAIM 24	'813 PATENT V. VERIZON
24[A]. The method of claim 18, wherein the dynamic modification further includes modifying a restriction on one or more protocol types.	Verizon's network services implementation of dynamic resource allocation allows for modifying a restriction on one or more protocol types. For example, a customer may be limited to 3G data delivery only: **3G vs 600Kb after 10G of data** DANHIL71 Member 31 08-21-2017 03:36 PM I signed up for a new Verizon account on July 5 - by July 9th I had gone through the first 10G - I am taking a class online and knew that would be the case - I received my message: "Your 4G ... has reached its 4G LTE data allowance.... Your 4G Internet will be switched from 4G LTE speed to 3G speed for the rest of your bill cycle." This worked fine for the whole month, as this reduced speed was still sufficient for me to continue attending my online class. https://community.verizon.com/t5/4G-LTE-LTE-Advanced/3G-vs-600Kb-after-10G-of-data/td-p/1028132 (last visited Feb. 27, 2022).

CLAIM 25	'813 PATENT V. VERIZON
25[A]. The method of claim 18, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.	Verizon's network services implementation of dynamic resource allocations includes receiving the service profile for each of the plurality of devices via one or more of: accessing a memory of the computing system or receiving data via a network link. *See* 1[B], 1[C] (detailing SPR and UDR). **Introduction** The UDC concept (3GPP TS 22.101 [3]) supports a layered architecture, separating the data from the application logic in the 3GPP system, so that user data is stored in a logically unique repository allowing access from core and service layer entities, named Application Front Ends. Network elements and functionalities should be designed to access user data remotely and without storing them permanently locally, i.e. the Front Ends shall work in a subscriber dateless configuration. 3GPP TS 23.335 version 16.0.0 Release 16 at 5 (2020-07).

4 User Data Convergence architecture

4.1 UDC System architecture

Figure 4.1-1 presents the reference UDC architecture. UDC is the logical representation of the layered architecture that separates the user data from the application logic, so that user data is stored in a logically unique repository allowing access from entities handling an application logic, hereby named Application Front Ends.

In the architecture, the User Data Repository (UDR) is a functional entity that acts as a single logical repository of user data and is unique from Application Front End's perspective. Entities which do not store user data and that need to access user data stored in the UDR are collectively known as application front ends.

NOTE: Depending on the different network deployment, there may be more than one UDC in an operator's network.

Application Front Ends connect to the UDR through the reference point named Ud to access user data.

Reference points towards network elements are marked in discontinuous lines in Figure 4.1-1, and are just shown for information purposes only. Details of the roles of these functional entities are described in sections 4.2.1, 4.2.2, 4.2.3 and 4.2. 4.

3GPP TS 23.335 version 16.0.0 Release 16 at 8 (2020-07); *see also id.* at 9 (illustrating and describing UDC reference architecture).

4.2.3 User Data Repository

The User Data Repository (UDR) is a functional entity that acts as a single logical repository that stores converged user data. The user-related data that traditionally has been stored into the HSS /HLR/AuC, Application Servers, etc., is now stored in the UDR according to a UDC information model. UDR facilitates the share and the provisioning of user-related data throughout services of 3GPP system.

3GPP TS 23.335 version 16.0.0 Release 16 at 11 (2020-07).

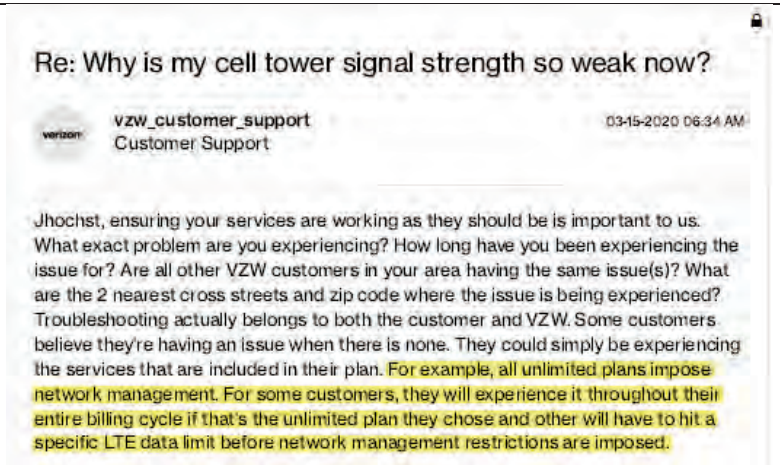
	The UDR functional entity may be distributed over different locations or be centralized; it may support replication mechanisms, back up functions and geographical redundancy to secure the storage of data. These functions are out of the scope of the present specification. They do not impact the functional content of the reference point Ud. The UDR shall be able to store the following types of data: - Permanent subscriber data: this is subscription data and relates to the necessary information the system ought to know to perform the service. User identities (e.g. MSISDN, IMSI, IMPU, IMPI), service data (e.g. service profile in IMS) and authentication data are examples of the subscription data. This kind of user data has a lifetime as long as the user is permitted to use the service and may be modified by administration means. - Temporary subscriber data: this is data which may be changed as a result of normal operation of the system or traffic conditions (e.g. transparent data stored by Application Servers for service execution, SGSN number, user status, etc.). 3GPP TS 23.335 version 16.0.0 Release 16 at 11 (2020-07). On information and belief, the service profiles are received by accessing a memory of the computing system or receiving that data via a network link within Verizon's network. *See* 1[B], incorporated herein.

CLAIM 26	'813 PATENT V. VERIZON
26[A]. The method of claim 18, wherein the dynamic modification is performed only if said network resource would be over-utilized by said traffic profiles.	*See* Claim 1[I] and 18[J], incorporated here.

CLAIM 27	'813 PATENT V. VERIZON
27[A]. A method for dynamic allocation of network resources comprising:	*See* Claim 1[A] and 18[A], incorporated here.
27[B] grouping, by a computing system of a cellular network, a plurality of computing devices sharing a cellular network resource;	*See* Claim 18[B], incorporated here.
27[C] receiving, by the computing system, a service profile for each of the plurality of devices sharing the network resource;	*See* Claim 1[B] and 18[C], incorporated here.
27[D] receiving, by the computing system, a billing profile for each of said plurality of devices;	*See* Claim 1[C] and 18[D], incorporated here.
27[E] generating, by the computing system, a prioritization list defining an order of said plurality of devices, within the group based on said billing	*See* Claim 1[D] and 18[E], incorporated here.

profiles and on a billing history for each of said plurality of devices;	
27[F] repeating, by the computing system, until said plurality of devices no longer continue to share said network resource:	Verizon's implementation of dynamic allocation of network resources includes repeating, by the computing system, steps 27[G]-27[K] below. *See* Claim 1[E], 1[J], 18[F] and 18[J], incorporated here.
27[G] receiving traffic profiles over said network resource for said plurality of devices, wherein the traffic profiles over said network resource indicate attributes of data communicated by corresponding ones of the devices using the network resource;	*See* Claim 1[F] and 18[G] (describing how Verizon's network services implementation receives traffic profiles over the network resource for the plurality of devices) and 21[A] (explaining how the traffic profiles indicate attributes of data communicated by the corresponding devices, such as data rates, data volumes, types of content, radio access type, congestion information, and device type), all incorporated here.
27[H] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	*See* Claim 1[G] and 18[H], incorporated here.
27[I] selecting at least one of said devices based on said prioritization list; and	*See* Claim 1[H] and 18[I], incorporated here.

27[J] dynamically modifying said service profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles, wherein the dynamically modifying includes modifying a restriction on communications for the at least one of said plurality of devices;	*See* Claim 1[I] and 18[J], incorporated here.
27[K] managing said network resource to according to at least one dynamically modified service profile; and	Verizon's implementation of dynamic allocation of network resources includes performing the step of managing said network resource according to at least one dynamically modified service profile. *See* Claim 27[J], 1[G] and 18[H], incorporated here. Implementing Verizon's Broadband Internet Access Services manages the shared network resources according to at least one dynamically modified service profile. For example, the shared network resource will allocate different capacity and/or data bit rates to customer devices depending on the prioritization of a particular customer during periods of congestion:

	 *See* https://community.verizon.com/t5/Verizon-Wireless-Services/Why-is-my-cell-tower-signal-strength-so-weak-now/td-p/1112558/page/23 (last visited Dec. 9, 2021). Additional examples and discussion relevant to this discussion are found in limitations 1[J] and 8[K]
27[L] when said plurality of devices are no longer sharing said network resource, the computing system clearing said prioritization list.	*See* Claim 1[K] and 18[L] , incorporated here.

CLAIM 28	'813 PATENT V. VERIZON
28[A]. The method of claim 27, wherein the network resource is a cellular base station or a back-haul link.	*See* Claim 19[A] (describing Verizon's network services using a cellular base station) and Claim 20[A] (describing Verizon's network services using a back-haul link), incorporated here.

CLAIM 29	'813 PATENT V. VERIZON
29[A]. The method of claim 28, wherein the traffic profiles over the network resource indicate: wherein the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type.	*See* Claim 21[A], incorporated here.

CLAIM 31	'813 PATENT V. VERIZON
31[A]. The method of claim 27, wherein the dynamic modification includes modifying a restriction on video content.	*See* Claim 23[A], incorporated here.

CLAIM 32	'813 PATENT V. VERIZON
32[A]. The method of claim 27, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.	See 25[A], incorporated here.

CLAIM 33	'813 PATENT V. VERIZON
33[A]. The method of claim 27, wherein the dynamic modification is performed if said network resource would be over-utilized by said traffic profiles and not if said network resource would be under-utilized by said traffic profiles.	*See* Claim 1[I] and 18[J] (describing dynamic modification in the event of network congestion).

CLAIM 34	'813 PATENT V. VERIZON
34[A]. A method for dynamic allocation of network resources comprising:	*See* Claim 27[A], incorporated here.
34[B] grouping, by a computing system of a cellular network, a plurality of computing devices sharing a cellular network resource, wherein the cellular network resource is a base station or a back-haul link;	*See* Claim 27[B], 28[A], incorporated here.
34[C] receiving, by the computing system, a service profile for each of the plurality of devices sharing the network resource;	*See* Claim 27[C], incorporated here.
34[D] receiving, by the computing system, a billing profile for each of said plurality of devices;	*See* Claim 27[D], incorporated here.
34[E] generating, by the computing system, a prioritization list defining	*See* Claim 27[E], incorporated here.

an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;	
34[F] repeating, by the computing system:	Verizon's implementation of dynamic allocation of network resources includes repeating, by the computing system, steps 34[G]-34[L] below.
34[G] receiving traffic profiles that indicate attributes of current traffic activity over said network resource for each of said plurality of devices;	*See* Claim 1[F], 18[G] and 27[G] , incorporated here.
34[H] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles, wherein the traffic profiles indicate data rates, data volumes, and types of content for ones of said plurality of devices; and,	*See* Claim 1[G], 18[H] (describing managing a network resource according to service and billing profiles if the resource is fully utilized) and Claim 21[A] (describing that the traffic profiles indicate data rates, data volumes, and types of content, among other parameters) , incorporated here.
34[I] selecting at least one of said devices based on said prioritization list and	*See* Claim 1[H] and 18[I], incorporated here.

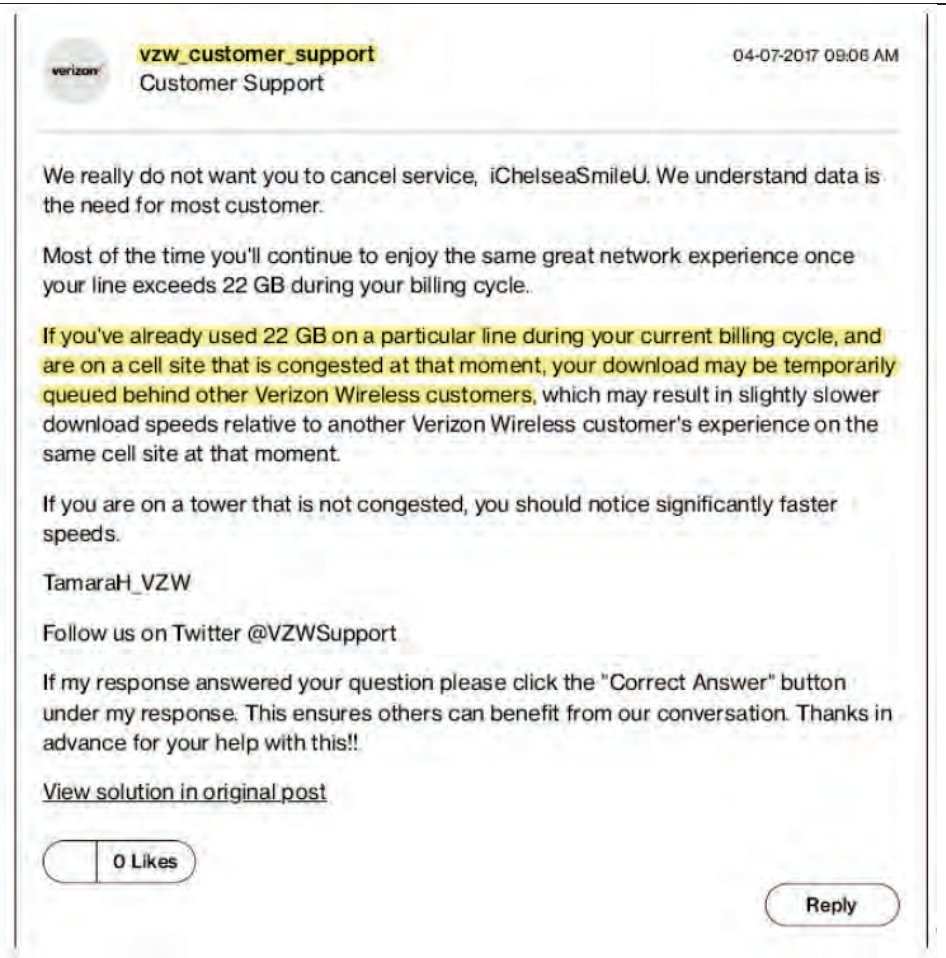
34[J] dynamically modifying said service profile for said at least one selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles wherein the dynamic modification includes:	*See* Claim 1[I] and 18[J], incorporated here.
34[K] automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource; and	*See* Claim 1[I] and 18[J] , incorporated here.
34[L] adjusting a restriction on one or more multimedia content types in response to contention for the shared network resource;	*See* Claim 23[A] (describing that Verizon's network services reduce the typical speed of video streams during periods of congestion, which adjusts the restriction on the default speeds, which vary by plan, for video streaming) , incorporated here.
34[M] until said plurality of devices no longer continue to share said network resource; and	Implementing Verizon's network services provides for repeating steps 34[G]-35[L] until said plurality of devices no longer continue to share said network resource. *See* Claim 1[J] and 18[K] , incorporated here.

34[N] when said plurality of devices are no longer sharing said network resource, the computing system clearing said prioritization list.	*See* Claim 1[K] and 18[L] , incorporated here.

CLAIM 35	'813 PATENT V. VERIZON
35[A]. The method of claim 34, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.	*See* Claim 25[A] (describing a similar limitation).

CLAIM 36	'813 PATENT V. VERIZON
36[A]. The method of claim 34, wherein the dynamic modification is performed if said network resource would be over-utilized by said traffic profiles and not if said network resource would be under-utilized by said traffic profiles.	*See* Claim 33[A] (describing a similar limitation).

CLAIM 37	'813 PATENT V. VERIZON
37[A]. An apparatus for dynamic allocation of network resources in a cellular network comprising:	*See* Claim 10[A] (describing a similar limitation).
37[B] a network interface configured to receive a service profile for each of a plurality of devices sharing a hardware network resource and to receive a billing profile for each of said plurality of devices; and	*See* Claim 10[B] (describing a similar limitation).
37[C] a processor connected to said network interface and configured to group the plurality of devices sharing the cellular network resources and generate a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices;	The server(s) identified in 10[B] include processors and are configured to generate a prioritization list consistent with the methods described in limitations 1[D] and 18[B], incorporated herein. The specific identity of the server/processor that generates the prioritization list will be provided once discovery is completed on the Verizon internal network architecture and software used to implement the method described relative to Claims 1 and 18. Implementing Verizon's network services includes a processor that is connected to the network interface and groups the computing devices (*e.g.*, the smartphones, basic phones, tablets, netbooks, USB modems, mobile hotspots and other wireless devices" described at TMCPO, p. 6) that share a cellular network resource, such as a "cell site" (*see* TCMPO at 5). For example, Verizon's cellular network identifies the devices connected to a cell site or base station at times when that network resource is congested:



vzw_customer_support
Customer Support

04-07-2017 09:06 AM

We really do not want you to cancel service, iChelseaSmileU. We understand data is the need for most customer.

Most of the time you'll continue to enjoy the same great network experience once your line exceeds 22 GB during your billing cycle.

If you've already used 22 GB on a particular line during your current billing cycle, and are on a cell site that is congested at that moment, your download may be temporarily queued behind other Verizon Wireless customers, which may result in slightly slower download speeds relative to another Verizon Wireless customer's experience on the same cell site at that moment.

If you are on a tower that is not congested, you should notice significantly faster speeds.

TamaraH_VZW

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If my response answered your question please click the "Correct Answer" button under my response. This ensures others can benefit from our conversation. Thanks in advance for your help with this!!

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VZ Community at 3-4.

Further, the processor generates a prioritization list to implement the network management. *See* Claim 1[D] (describing generating a prioritization list).

37[D] wherein said processor further configured to repeat:	Verizon's implementation of dynamic allocation of network resources includes repeating steps 37[E], 37[F], 37[G], and 37[H] below.
37[E] receiving traffic profiles over said network resource for said plurality of devices;	*See* Claim 10[E] (describing a similar limitation).
37[F] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	*See* Claim 10[F] (describing a similar limitation).
37[G] selecting at least one of said devices based on said prioritization list; and	*See* Claim 10[G] (describing selecting a device based on a prioritization list).
37[H] dynamically modifying said service profile for said selected devices, if said network resource is underutilized by communications corresponding to said traffic profiles or if said network resource would be over-utilized by communications corresponding to said	*See* Claim 18[J] (describing dynamically modifying the service profile by reducing a maximum guaranteed bit rate). Reducing a maximum guaranteed bit rate is an example of Verizon's network services modifying a restriction on communications for the at least one of said plurality of devices. Another example is by reducing the typical speed of video streams during periods of congestion, which vary by plan, for video streaming. *See* Claim 23[A].

traffic profiles wherein the dynamically modifying includes modifying a restriction on communications for the at least one of said plurality of devices;	
37[I] until said plurality of devices no longer continue to share said network resource; and	*See* Claim 10[H] (describing a similar limitation).
37[J] wherein said processor is further configured, when said plurality of devices are no longer sharing said network resource, to clear said prioritization list.	*See* Claim 10[I] (describing a similar limitation).

CLAIM 38	'813 PATENT V. VERIZON
38[A]. The apparatus of claim 37, wherein the restriction on communications is a guaranteed bit rate.	*See* Claim 18[J] (describing dynamically modifying the service profile by reducing a maximum guaranteed bit rate). Reducing a maximum guaranteed bit rate is an example of Verizon's network services modifying a restriction on communications for the at least one of said plurality of devices.

CLAIM 39	'813 PATENT V. VERIZON
39[A]. The apparatus of claim 37, wherein the network resource is one of a cellular base station or a backhaul link.	*See* Claim 19[A] (describing the network resource as base station) and Claim 20[A] (describing the network resource as a back-haul link).

CLAIM 40	'813 PATENT V. VERIZON
40[A]. The apparatus of claim 37, wherein the processor is configured to perform the dynamic modification only if said network resource would be over-utilized by said traffic profiles.	*See* Claim 26[A] (describing a similar limitation).

CLAIM 41	'813 PATENT V. VERIZON
41[A]. A computer-implemented method for dynamic allocation of network resources comprising:	*See* Claim 18[A] (describing a similar limitation).
41[B] grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;	*See* Claim 18[B] (describing a similar limitation).
41[C] receiving a service profile for each of the plurality of devices sharing the network resource;	*See* Claim 18[C] (describing a similar limitation).
41[D] receiving a billing profile for each of said plurality of devices;	*See* Claim 18[D] (describing a similar limitation).
41[E] generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing	*See* Claim 18[E] (describing a similar limitation).

history for each of said plurality of devices;	
41[F] repeating, by the computing system:	Implementing Verizon's network services provides for repeating, by the computing system, steps 41[G]-41[J] below.
41[G] receiving predetermined traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;	*See* Claim 18[G] (describing a similar limitation).
41[H] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	*See* Claim 18[H] (describing a similar limitation).
41[I] selecting at least one of said devices based on said prioritization list; and	*See* Claim 18[I] (describing a similar limitation).
41[J] dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if	*See* Claim 18[J] (describing a similar limitation).

said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource;	
41[K] until said plurality of devices no longer continue to share said network resource; and	*See* Claim 18[K] (describing a similar limitation).
41[L] when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	*See* Claim 18[L] (describing a similar limitation).

CLAIM 42	'813 PATENT V. VERIZON
42[A]. A computer-implemented method for dynamic allocation of network resources comprising:	*See* Claim 18[A] (describing a similar limitation).
42[B] grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;	*See* Claim 18[B] (describing a similar limitation).
42[C] receiving a service profile for each of the plurality of devices sharing the network resource;	*See* Claim 18[C] (describing a similar limitation).
42[D] receiving a billing profile for each of said plurality of devices;	*See* Claim 18[D] (describing a similar limitation).
42[E] generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing	*See* Claim 18[E] (describing a similar limitation).

history for each of said plurality of devices;	
42[F] repeating, by the computing system:	Implementing Verizon's network services provides for repeating, by the computing system, steps 42[G]-42[J] below.
42[G] determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;	*See* Claim 18[G] (describing a similar limitation).
42[H] managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	*See* Claim 18[H] (describing a similar limitation).
42[I] selecting at least one of said devices based on said prioritization list; and	*See* Claim 18[I] (describing a similar limitation).
42[J] dynamically modifying at least one of said service profile and said billing profile for the selected devices, if said network resource is under-utilized by said traffic	*See* Claim 18[J] (describing Verizon's Broadband Internet Access Services dynamically modifying a service profile by reducing a maximum guaranteed bit rate).

profiles or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource;	
42[K] until said plurality of devices no longer continue to share said network resource; and	*See* Claim 18[K] (describing a similar limitation).
42[L] when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	*See* Claim 18[L] (describing a similar limitation).